Popular Astronomy.

Vol. XXV, No. 9. NOVEMBER, 1917. Whole No. 249.

REPORT ON MARS, No. 18

Suggestions and General Data.

WILLIAM H. PICKERING.

In planning our work for the coming opposition it will be well to consider first the conditions which determine the date on which the observations may profitably be begun. It is of no use except for some especial investigation to attempt to observe the planet when it is within 3^h of the Sun. This is not so much because the planet is then so small, but rather that its altitude is then too low, even at sunrise, to distinguish much detail upon its surface. If we turn to the column headed "Transit Meridian of Greenwich" under Mars in the *American Ephemeris* p. 162, we shall find that the hour constantly diminishes, since Mars is an exterior planet. It reaches 20^h, which means that Mars is 4^h west of the Sun, on October 12, 1917. This is about the first date that it could be really profitably observed in the temperate zones. The declination at this time is $+16°.7$. Turning now to the "Ephemeris for Physical Observations" in the same volume, we find that the solar longitude $\odot$ is $17°.7$, corresponding to the Martian Date March 37 (See Report No. 10). Spring will thus have begun, the yellow north polar cloud cap will have dissipated, and the white polar snow cap be visible and very large, but diminishing in size. Vegetation in the southern hemisphere will also have taken on its bright green hue. According to the *Ephemeris* the diameter of the planet on this date is given as $5''.47$. Making the correction described in Report No. 15, this is reduced to $5''.07$. Although this is rather a small disk, yet with good seeing it is ample to enable us to detect considerable detail, and those who are sufficiently enthusiastic to be up before sunrise may obtain observations at any time after this date which will be of use in solving the mysteries of the planet, and especially in recording the dates of the periodic floods occurring upon its surface in the northern portion of the Syrtis Major. These observations are much to be desired, since no more can be obtained to advantage after next January for a number of years (See Report No. 17).

Any person desiring to contribute drawings suitable for publication at the conclusion of the opposition should consult Reports No. 11 and 15 for specifications. In these drawings the axis of the planet should be vertical, and its position indicated by short lines drawn on the disk at the poles, as shown in Report No 17, Figures 2, 6, 10, 14, 18, and 22. In these particular figures, however, the northern lines have been erased by the engraver in whitening the polar cap, leaving only the southern ones. In this connection it may be pointed out that if a special observing book is reserved for the planet, and any considerable part of the suggestions made in these reports adopted, it will be found convenient to copy into the beginning of it the Standard Scale of Seeing from Report No. 9, and also Tables I and II from Report No. 15.

The date of the coming opposition is March 14, 1918, and the six drawings should all be made between February 10 and April 20 inclusive, and the finished results mailed to the writer at Mandeville, Jamaica, B. W. I., not later than May 20. If a complete set of drawings cannot be obtained, it is possible that some of those furnished may still be published if they are really good, and the central meridians are near the adopted longitudes. Sufficient information must be given with each drawlng to make it possible to fill out a table similar to Table I in Report No. 17. Observers are cautioned not to draw anything unless they are sure of it, and particularly not to attempt to see too many lakes and canals. Those seen by only one observer count against his drawings. Especial attention should be paid to the shapes and detail of the more readily seen features. The drawings should always be made by the observer seated at the telescope, in order that they may constantly be corrected by comparison with the planet itself. One observer with whom the writer was acquainted formerly made his drawings at a little table near the telescope, going back and forth between the two, and in this way obtained results differing in some marked respects from those of other astronomers. The danger of this method is that preconceived impressions of what it is thought the detail should be, will take the place of facts. Small changes of detail are also liable to pass unnoted. Observers should on no account take a map of the planet to the telescope in order to hunt for previously recorded canals and lakes. This would not only prejudice their work in favor of those already known, and in favor of locations already recorded, but also in favor of the particular map they selected to use, all of which prejudices are distinctly objectionable.

It would appear to the writer in looking over the drawings in Report No. 17 that the two reflectors did excellent work, and that for a moderate priced instrument intended for use on planetary or lunar detail, the same amount of money spent on a reflector will secure

better results than if spent on a refractor. It is suggested that each observer who made records at the last opposition should compare his drawings with what might be described as a composite of all the drawings published in Report No. 17, criticize them, note the differences and the coming year make a point of deciding for himself which was right. It is unfortunate that half the observers of region B failed to secure drawings when longitude 60° was near the central meridian. This causes these drawings to appear more unlike than is really the case.

In region C, longitude 120°, the divergence is real, and due to the fact that very little contrast was shown by the planet. What little there was had to be greatly exaggerated by the observers in order to show it at all. Figures 12 and 30 are the most divergent, the others apparently all saw about the same thing, although it was imperfectly distinguished by them. After the period at which these drawings were made, however, this region began to show more detail. When ☉ had reached 73°.7 Tithonius stretched itself far beyond Phoenicis Lacus to longitude 120°, and Gigas confirmed its name, by assuming an enormous width of some 500 miles. It was evident that this region was only awaiting its turn, until the development of the other regions to the east and west of it was completed. At the coming opposition we shall therefore be able to study it to more advantage, and it is possible that instead of being the least interesting region on the planet, it may prove to be the most so. Near its center is found the shifting Nodus Gordii, whose position should be accurately determined whenever possible, and which it is expected may also show changes in density, perhaps from hour to hour. That many canals may develop is also possible, to say nothing of Phoenicis Lacus, which is at times a very marked object, but of late has been seldom recorded.

A careful and beautifully illustrated record of observations made in February 1916 has been received from Mr. McEwen, but too late to appear in any of the former Reports. It is of interest that he describes and illustrates Aurorae, Margaritifer, and Sabaeus as of a full Delft blue, while Acidalium is neutral tint. The writer made a number of color sketches in January and February, Only two, however, one of January 30 and the other of February 26 show these regions. On the former Acidalium is neutral tint, Sabaeus brown, and the region south of Margaritifer green. On the latter, which was considered particularly satisfactory, Acidalium was a gray blue, and Sabaeus, Margaritifer, and Aurorae neutral tint. Nothing like a Delft blue has been seen on any occasion during the last two oppositions in the equatorial regions of the planet. Color observations of these small regions are very difficult to make with a small telescope, but it is probable that the chief cause

of the difference in the results is due to the color of the artificial light employed to illumine the paper. Mr. McEwen uses an oil flame, which gives results for the reds and yellows in close accordance with the writer's. The writer uses, as described in his recent paper on "The Colors of the Stars and Planets," a tungsten lamp shining through a combination of blue glass. More or less blue glass is added until the color of the northern snow cap of the planet exactly matches the white paper on which the color sketch is to be made. It is thought that the various colored regions of the disk should then be correctly represented. In case the snow cap is concealed by clouds, blue glass is added until these appear of a pale straw color.

Attention is again called to the desirability of recording the first appearance of Aryn in the Sinus Sabaeus. At the last opposition although especial attention was drawn to this matter, much divergence of testimony is given, those who were particularly looking for it seeing it in general much later than those who were not. While the latter undoubtedly thought they saw it, and perhaps did, it is suggested that they may have drawn it, merely because they expected it, and thought it ought to be there. Messrs. Lau and McEwen failed to see it as late as February 20. Mr. Phillips, Professor Douglass, and the writer all thought it appeared at about the same time, between February 27 and March 7. The mean solar longitude ☉ would be 62°. Although carefully looked for in 1914 the writer was pretty sure it was not really visible before March 21, when he suspected it, at ☉ 51°. He did not feel at all sure of it, however, even then. On the other hand M. Jarry Desloges in a recent letter declares that he saw it both in December and January of the past opposition, thus fully confirming Mr. Wilson, who drew it as clearly visible January 23. On January 23, 24, and 30 the writer felt particularly certain that it was not visible, the seeing being 6, 7 and 9. The question is therefore still undecided, and special drawings of this region should be made whenever possible this coming winter. The planet will reach ☉ 62° on January 19. The development of this point is of particular interest since it is the assumed origin of longitudes upon Mars.

The maximum diameter of the planet at this opposition will be 15″.27 according to the ephemeris. Correcting this by dividing it by 13.6 and subtracting the result, gives us 14″.15 for its true diameter, or a trifle larger than at the previous opposition. This correction applies to all the European almanacs as well as to the *American Ephemeris*. The writer has been informed from Washington that the required change to avoid this correction will be made in the ephemeris for 1920, but that it was impossible to make the necessary corrections before that date. All the almanacs will then be changed. Those American

observers who are interested in Mars will also be glad to hear that, beginning with 1920, the ephemeris will be calculated for Greenwich midnight instead of noon, thus making interpolations more accurate and convenient, and that the central meridian will be given for every day instead of only for alternate days as heretofore.

For those wishing to study the planet seriously, and who are willing to get up early to observe it, the following plan is recommended. The hours at which it is practicable to observe the meridians 0°, 60°, 120°, 180°, 240°, and 300°, when transiting the center of the disk, should be computed for every day from the date when "Transit Meridian of Greenwich" reaches 20^h until it drops to 4^h, or from October 12, 1917, to August 24, 1918. This is readily done by following the instructions given in Report No. 15. At least one drawing should be secured in each of these six positions of the planet for every presentation between these dates. This means in general that one drawing must be made every six days. Unfortunately in 1918 the Physical Ephemeris of Mars is not published after July 2, but this will be remedied for future oppositions. Between the dates when the planet occupies the same position in its orbit that it did at the last and at the following oppositions, namely those of 1916 and 1920, additional drawings should be secured. These are obtained when the meridians 30°, 90°, 150°, 210°, 270°, and 330° are central. In 1916 opposition occurred on February 9. Adding 687 days, the sidereal period of Mars, brings us to December 27, 1917, when Mars will attain the same position in its orbit, and the series of additional drawings should be begun. The ephemeris for 1920 is not yet out, but opposition will occur about April 21. Subtracting 687 days from this, would give us June 4, 1918, for our later date. Between these two dates then at least one drawing should be secured every three days.

If this plan of work is carried out at every opposition, we shall at the end of fifteen years have two independent sets of drawings, made in different years, in every 30° of longitude upon the planet, throughout the whole of the Martian year. Besides this we shall have numerous other drawings made in every 60° of longitude when the planet was more remote from the earth. Such a series was begun two years ago at this observatory, and it is hoped that some other observer may feel inclined to follow out the same or a similar plan elsewhere. It is much better to secure a comparatively few carefully executed drawings each year than to make a great number of irregularly distributed careless sketches, many of which are duplicates.

At each successive opposition we see the planet at a somewhat later season of its year than at the previous one. Thus prior to November 17 of this year, when the solar longitude ☉ reaches 34°.1, and the Martian

date is April 15, the planet will be in a portion of its orbit which we were able to study to more advantage in 1914 than we can the present year. That is to say we were nearer to the planet then than we shall be now. From November 14, 1917 until February 5, 1918, when ⊙ reaches 69°.4 and the Martian date is May 37, the planet will be gradually getting nearer to us, but will not be as near as it was in 1916. After February 5, 1918, however, the planet will have reached a portion of its orbit, that is to say a season of its year, in which we have not been able to study it to as much advantage for the past fifteen years.

It will reach its summer solstice on March 24, Martian date June 27, only ten days after opposition, and but six days after its nearest approach to the Earth. It will therefore be placed in an unusually favorable position for the study of its more northerly latitudes. Indeed so favorable an opposition for this purpose will not occur again for a great many years. The declination is also favorable to northern observers. After October 31 the inclination of the plane of its equator to the line of sight will not fall below 21° for the remainder of the opposition. Special attention should therefore be paid to the melting of the snow cap, and the sudden formation in it of rifts. These latter will generally occur early in the season. When they appear, the polar marshes immediately increase in size, and clouds form in their western borders. Following them the marshes slowly travel westerly, that is to higher longitudes. This will evidently not be a favorable year for detecting an early snowfall in the southern hemisphere. It may be, however, as the winter season progresses in 1918, that we shall then see something of the southern snows, if they are not entirely concealed by clouds. The southern polar cap, unlike the northern one, is eccentric and extends farthest north in longitude 30°, near Margaritifer.

It was noted in Report No. 13 that the northern snow cap extended 5°, or 185 miles, farther south during the opposition of 1916 than it had in the previous one. Later in the Report it was suggested that it would be a matter of interest to see if a colder winter on Mars was followed by a colder winter on the Earth. While the writer has no general figures available to settle this question, the popular reports were that it was an unusually long, cold winter, both in America and Europe. The mean temperatures for this station will be published elsewhere, but the fluctuations in the tropics are usually so regular, that we are enabled to look at the matter in consequence from a somewhat different standpoint. During the five previous winters we have had in all 22 cold nights, that is nights when the minimum thermometer fell to 60°.0, the lowest temperature recorded being 56°.1. In this past winter alone we had 28 cold nights, or more than in all the other five years put together, five of them falling in April. During the past five years

we have had in all 71 hot days, that is days on which the maximum thermometer registered above 85°.0. The number per year ranged from 8 to 22, the highest temperature recorded being 89°.2. This year on only one day did the thermometer exceed 85°.0, and then it rose to 86°.5. It therefore appears that a cold winter on Mars has been followed by an unusually cold year in Mandeville, and perhaps elsewhere in the tropics.

What will make this opposition an especially interesting one, however, is the fact that this year the canals are expected to reach their maximum number. But it is also believed that they will be finer and more delicate than heretofore. We shall therefore require the best of seeing to draw them to advantage. They will probably also be straighter and more artificial looking than of recent years. The double effect due to refraction, caused by rapidly passing waves in our own atmosphere should be well seen. These conclusions are based largely on what was observed towards the end of the last opposition, and in part on the observations of other years. If the markings on the planet ever present a distinctly artificial appearance, they should do so this year. An especial effort should therefore be made to secure any facts that will throw light on their nature, their method of formation and disappearance. Observers should be particularly on the lookout for any curvature that they may possess, since when poorly seen the tendency is always to draw them as straight lines. At the same time there is strong evidence that many of the longer ones really are straight, as seen with our best optical powers. Written notes on the straightness of particular canals are very desirable.

While as many as 33 lakes were noted at the last opposition, it is unfortunate that only twelve of them were seen by more than one observer, and a certain amount of doubt is therefore thrown not only over the remaining 21, but even over some of those that were recorded by two observers, as possibly being merely accidental coincidences. The existence of the eight lakes seen by three or more observers seems to be fairly assured, and doubtless many of the others were genuine. Perhaps the fault really lay with those observers who saw too few lakes, and that they devoted their attention too exclusively to the canals. It is believed in general that the lakes appear rather later than the canals, and therefore observers should make a point of looking for them at the coming opposition. While their visibility may be best recorded by means of a Scale of Lakes attached to the telescope, such, as is described in Report No. 7, another way of recording them is by comparing them with the lunar lakes as seen in an ordinary opera glass, as is described in Report No. 6. All good opera glasses of the older type magnify two and a half times, so that this magnification may be looked on as a standard.

Hourly Changes in the Canals.

It is fairly certain that a number of the canals are simply marshes. This is shown in part by the clouds following them, but mainly by their changes in breadth and density from hour to hour. The so-called canals bounding the polar cap grow distinctly darker and broader as the Martian day wears on, and as the snow melts under the midday Sun. They usually retreat with the snow cap as that gradually diminishes in size, but later in the season they are sometimes left behind by it, another canal forming between them and the snow. They often recede from the snow in a diagonal direction, forming thus very elongated marshes (See Reports Nos. 4 and 14). Ephemeral canals are not however confined exclusively to the vicinity of the snow cap. Some very striking ones were found in the Protei Regio in 1914 (See Report No. 8).

Still another variety of change has been noted in other canals situated near the equator. Instead of growing darker as the Sun gets higher, they grow lighter. Thus on November 26, 1915, Casius, in latitude + 40°, was strikingly dark 30° before reaching the central meridian. Two hours later, when it transited, it was much fainter, being even less marked than the Syrtis, which was nearer the limb (See Report No. 13). There had clearly been a heavy precipitation during the previous night in this region, and a rapid evaporation the following morning, as the warm spring Sun approached its meridian. It appears therefore that while the canals grow darker towards noon in the polar regions, they grow lighter towards noon nearer the equator. A dark spot which shifts about into different positions, and is seen sometimes in one place and sometimes in another, in the vicinity of the region marked Nodus Gordii is evidently a marking of this character (See Report No. 13).

In a recent letter from one of our associated members, Dr. Lau, he says "My drawings show (or appear to show) a very curious fact regarding the faint halftones between Gehon, Deuteronilus, and the place of Hiddekel, (Hiddekel being invisible in my 4-inch). I have never been able to see those shades after the transit through the central meridian. It is absent on 22 drawings from 1914 and 1916! Boiled away?" An examination of my own drawings entirely confirms Dr. Lau's observation, and I feel there is no question but that, owing to the low pressure of the atmosphere of Mars, his explanation that the moisture has evaporated is correct.

The question immediately presents itself to us, are all the canals merely marshes, or are some of them due at least in part to semi-

permanent strips of vegetation? This is a most important question, and under the unusually favorable conditions occurring this year we should all endeavor to obtain as much light upon it as possible. At the last opposition the straight narrow canals suddenly appeared March 1, prior to that only broad curved ones being visible. The value of ⊙ was 61°.5 and the Martian date May 19; the corresponding date this coming year will be January 18, diameter of planet 9″.5. It is very improbable that the exact date will be confirmed, but we need hardly begin to look for the narrow canals before January. From then on, all possible information should be gathered relating to their first and last appearance, and especially as to their visibility at different hours of the Martian day.

Our associate Mr. Wilson in a very interesting paper on Mars published in the Monthly Register of the Society for Practical Astronomy, 8, 51, speaking of the canals says "During the 1916 opposition they developed first as colorless gray lines, then became pale emerald and finally were seen a richer tone of dark blue-green. The canal Thoth is an example of this development." This observation, which of course applies only to the broad curved canals, would if confirmed certainly indicate vegetation, but the writer has hitherto generally found even these canals too narrow to give very reliable indications of color. Or rather one should say they generally appeared to him gray. This may of course have been their true color. In 1914 however Cerberus and Sabaeus certainly appeared to be chocolate brown (See Report No. 10). In 1882 Schiaparelli described some of the canals as reddish brown (Flammarion. Mars 1, 358). It is hoped that others will look into this matter.

Mr. Wilson mentions another subject of great interest in his paper. Many persons have suggested that if the so-called "seas" of Mars were really water, that under proper conditions we should at times see the image of the Sun reflected in their surfaces as a small brilliant spot of light. The writer has looked for this phenomenon on several occasions when the Syrtis Major was near the center of the disk, and the color indicated that the marsh was more or less flooded. He has never succeeded in assuring himself however that he had detected the phenomenon in question. Mr. Wilson says in referring to this matter "While such a high light is certainly not conspicuous, it has been seen when it falls upon the vast yellow regions of the planet. The smaller dark markings and the canals have been observed to become less distinct while passing through it. When the general surface is of a light tint the high-light effect is less noticeable." Now the question at once suggests itself, is Mr. Wilson's explanation of his observation the true one? A smooth dull sphere would, when in opposition, present a

perfectly uniform surface to us. In order to appear brighter at the center the surface must present a certain amount of specular reflection. If true, that of itself would be an interesting matter. But is it not more likely that we have here another illustration of the drying up of the canals towards noon, noted by Dr. Lau and the writer? This observation should certainly be repeated at the coming opposition, and an especial note made as to whether the canals reappear towards sunset after having passed the center of the disk, also their relative intensity at equal distances on opposite sides of the center.

But here as in so many other cases in our studies of Mars, we find that these observations are not new. Cerulli in 1896 recorded that Titan appeared very fine when on the central meridian, but that it appeared much wider when at a distance of 30° from it. Schiaparelli records a similar observation with regard to Nodus Gordii and Solis Lacus, and explains it by saying that the surrounding bright regions when near the limb were brighter and therefore brought out the dark markings by contrast (Flammarion. Mars 2, 316 326). There can be little doubt but that a phenomenon discovered independently by so many different observers really exists, and must be taken into account in any explanation that is offered to account for the canals.

Somewhat analogous observations should be made regarding any clouds that are noted. We have all noticed how rapidly clouds, conspicuous at sunrise, disappear as the region approaches the central meridian. Do they reform with similar rapidity when near the limb towards sunset? A series of drawings made a few minutes apart, showing the gradual dissolution or formation of a large cloudy area located as far as possible from the limb would certainly be of interest. Such an area was noted on December 7, 1915, ⊙ 23°.8 (See Report No. 14). It is suggested that at this opposition an especial effort be directed to the study of hourly changes in the canals, and of changes still more rapid occurring in the clouds that are found near the limb of the planet.

Shifting of the Canals over the Surface.

It may be thought by some that sufficient evidence has already been furnished from the work of various observers in Reports Nos. 5, 16, and elsewhere, to show that the boundaries of the dark markings, and with them the canals, are subject to a continuous gradual shift back and forth over the surface of the planet, both in latitude and longitude.

Nevertheless the very last letter that the writer received from the late Dr. Lowell indicated doubt on his part regarding the matter. Whether he changed his mind after it was shown that his own obser-

vations furnished one of the strongest arguments in favor of such a shift, the writer does not know. It will be recalled that in 1894 Lowell found that Aryn passed the central meridian by "the unmistakable amount of twenty minutes behind time," 4°.8 of longitude. In 1914 he found it 2°.9 ahead of its earlier position, and within 1°.0 of the position assigned to it in 1879 by Schiaparelli. He gives the probable error of his observations as 0°.2. Now whatever the astronomical world in general may think of Dr. Lowell's drawings, and of his theories, there is no question whatever but that his measurements were very good indeed. Is is unlikely that either of his longitudes should have been in error by more than one degree. He had a fine instrument. his observations were accurate, and his computations sound. His determination of the position of the axis of the planet has been adopted as a standard by the associated nautical almanacs. His measurements were his strong point, and it is a pity he did not make more of them.

Other observers have found still larger deviations. Thus M. G. Fournier, at the observatory of M. Jarry Desloges, during 1911 found Aryn to shift through 7° of longitude, and 6° of latitude. Margaritifer also exhibited a large shift (Report No. 7). Dr. Lau in A. N. 4706 finds that as compared with his own work, Schiaparelli gives the longitude of Aryn as 4°.4 too high, and that of Margaritifer 2°.4 too low (Report No. 3).

As compared with the mean result, it is found that the average deviation of a good observation in either latitude or longitude is about 1°, or 37 miles on the surface of the planet. But no matter how accurate any observer's results may be, they can never be as satisfactory as the mean result of several different observers working at different stations. It is proposed therefore to the Associated Observers this year, and to as many others as would like to join them, that a united effort be made to secure observations of four points on at least one night, near the date of the coming opposition.

It is probable that the most accurate method of observation does not involve the use of a micrometer, but merely a thread in the field of the eye-piece. This thread should be placed parallel to the line joining the middle of the northern polar cap and the center of the disk. If a position circle is available the thread may be set to better advantage by means of the printed ephemeris. The time is then recorded when the point under observation and the center of the polar cap appear to be equally distant from the thread. which is placed first on one side of them, and then on the other. The observations should begin about ten or fifteen minutes before the point apparently reaches the central meridian of the planet, and an observation should be recorded at intervals of about a minute until

the transit is clearly over. A review of these records will enable the observer to decide when the actual transit occurred. To determine the latitude, two circles two or three inches in diameter are drawn on a sheet of paper, a vertical diameter representing the central meridian. On these the point to be observed is located, just before and just after the observations for longitude are made.

The four points selected can all be observed within two hours of one another. They are the preceding edge of Edom north of Sabaeus, the point of Aryn, the preceding edge of Thymiamata following Margaritifer, and Oxia Palus if visible, if not visible, the northern point of Margaritifer. The latitude observations will naturally refer to the southern side of Edom and Thymiamata. For map see Report No. 15. The adopted times of transit and the drawings should be sent to the writer as soon as the measurements are completed, or the positions may be computed by the observer himself, if preferred. They will then all be published together. If a number of observers are willing to contribute, we should, by avoiding the systematic error of the individual, probably obtain the most accurate determination of the positions of these points yet secured. The organization of the Associated Observers lends itself admirably to work of this character, and the writer will always be glad to receive suggestions from others as to how it may be most efficiently employed.

Observations.

Three observations of the planet have been made the present year. The first was on August 27, in longitude 260°, ⊙ 355°.8, diameter 4″.4. Both polar regions were yellow, but no brighter than the rest of the limb. The clouds therefore had not as yet cleared from over the northern snow fields. The dark band surrounding the polar cap had already formed, indicating that melting had begun. The Syrtis was broad and extended towards Thoth, which later was not yet visible. The next observation was made September 4, longitude 166°, ⊙ 359°.5, diameter 4″.5. The northern snow cap was now clearly seen, and extended to latitude 63°.6. The maria were visible though small, and the color of the deserts number 12.0 on the Color Scale. The last observation was made on September 29, longitude 268°, ⊙ 11°.0, diameter 4″.8. The snow cap was readily visible, and reached the latitude 61°.2. The average of the two observations would make it of about the same size as in 1914, and distinctly smaller than at the last opposition. The snow was melting rapidly, as indicated by the breadth of the surrounding dark band, which had reached a width of 600 miles. But what was most striking in the two drawings

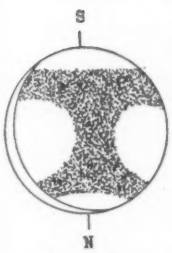


FIGURE 1.

secured on this night was the broad meridional band, which had again appeared, as is shown in Figure 1, and had attained a breadth in its narrowest portion of 900 miles. It therefore reached to the east to Triton, Thoth, and Alcyonius, completely across Casius, to the west to Nilosyrtis, and was distinctly wider than in our first observation.

This is the third opposition in succession in which this band has been recorded. At the two earlier ones a broad band appeared north of Sabaeus and near Margaritifer, connecting them with the polar regions (See plate in Report No. 11). But in both years a second band was visible, of the same shape as the present one, but only of about half its breadth, in this same place. It is surprising that at earlier oppositions so striking a phenomenon should have attracted so little attention or comment. A remarkable feature of the present phenomenon is that it should occur so late in the season. In 1913 and 1915 the band reached its maximum breadth and visibility, as far as the Jamaica observations show, at about $\odot = 330°$, corresponding to the Martian Date of February 1. This band, which doubtless has been visible for some time, is still very conspicuous at $\odot = 11°$, M. D. March 23. At the two previous oppositions but the merest traces of it were left after March 1. Since either as a storm track or marsh, it indicates the passage of huge volumes of water from the polar regions to the southern maria, we should naturally expect the season to be later on Mars at this opposition than usual. Now this is exactly what we find to be the case, for although carefully looked for, no green has as yet been detected in the maria, which are still of identically the same color as the northern marshes. At the two previous oppositions green was first noticed about February 39 and 43 (Report No. 12).

A slight darkening was detected near the place of the Syrtis marsh, but it was indistinct, and clouds interfered before it could be accurately located. The customary table of data follows. Since the published ephemeris does not begin until October 1, they have been in part obtained by extrapolation.

TABLE I.

DATA OF THE OBSERVATIONS.

No.	1915	⊙	M. D.	Long.	Lat.	Sun	Diam.	Seeing
		°		°		°	″	
1	Aug. 27	355.8	Feb. 48	260	—	−1	4.4	10
2	Sept. 4	359.8	" 56	166	—	0	4.5	10, 6
3	" 29	11.0	Mar. 23	268	+16°	+4	4.8	8, 10

No lakes or canals were visible.

Mandeville, Jamaica, B. W. I.
Oct. 3, 1917.

THE TOTAL ECLIPSE OF THE MOON OF 1917, DECEMBER 28.

WILLIAM F. RIGGE.

The eclipse of December 28 next is exceptional in that, (1) it is the seventh and last eclipse of this year,—seven being the greatest possible number that can occur in a year;—(2) it is the third total lunar eclipse, and (3) its magnitude is only one per cent more than total and the duration of totality only seventeen minutes. It will be completely visible all over the United States, although the time of its occurrence may be inconvenient. The accompanying diagram will give the details.

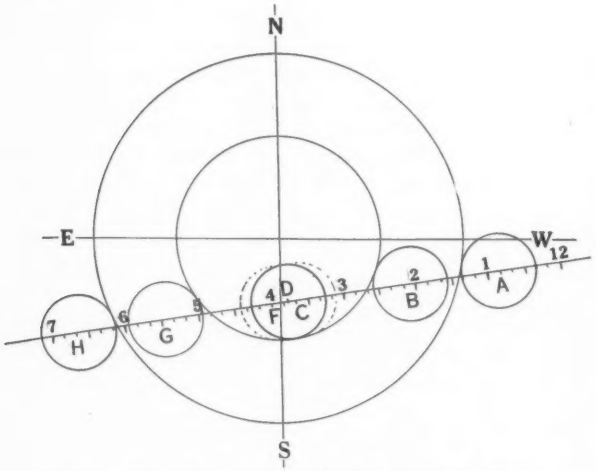


FIG. 1.—TOTAL ECLIPSE OF THE MOON, DECEMBER 28, 1917.

A—Moon enters Penumbra	12:54	A. M.	Central	Standard	Time
B—Moon enters Shadow	2:05	"	"	"	"
C—Total Eclipse begins	3:38	"	"	"	"
D—Middle of Eclipse	3:46	"	"	"	"
F—Total Eclipse ends	3:55	"	"	"	"
G—Moon leaves Shadow	5:27	"	"	"	"
H—Moon leaves Penumbra	5:39	"	"	"	"

The largest circle represents the cross section of the earth's penumbra, and the next one that of its shadow, at the place where the moon will cross them. N S E W are the cardinal points. The diagram must

therefore be held in such a way that the line NS points to the North Star. At midnight this line will be vertical, after that it will incline more and more to the right.

The long oblique line is the moon's path marked to full hours and ten-minute spaces of central time. The small circles represent the moon at important moments. When its centre is at A, at 12:54 A. M., the Moon enters Penumbra. At B, at 2:05, the Moon enters Shadow. At C, at 3:38, the Total Eclipse begins. At D, at 3:46, we have the Middle of the Eclipse, when the moon has entered most deeply into the Earth's shadow, the penetration being only one per cent more than the length of its diameter, so that the Magnitude is 1.01. The moon remains completely immersed in the shadow for only seventeen minutes, so that at F, at 3:55, the Total Eclipse ends. At G, at 5:27, the Moon leaves Shadow, and at H, at 6:39 the Moon leaves Penumbra.

THE TOTAL ECLIPSE OF THE SUN OF 1918, JUNE 8, AS VISIBLE IN THE UNITED STATES.*

WILLIAM F. RIGGE.

The maps herewith presented contain in a graphic and condensed form all the data concerning the coming total solar eclipse given by the *American Ephemeris*, together with some additional information. Those pertaining to the central line were obtained directly from the *Ephemeris*, all the rest were found from a graphic construction.

Figure 1. refers to the beginning of the eclipse. The full lines indicate the central times for every ten minutes. They are marked on the top of the map and on the right, the large 4 meaning 4 o'clock, and the 40, 50, 10, 20, 30, 40, the minutes preceding and following. The dotted lines marked from N60W to S70W, W meaning due West, indicate the position angles, counted from the Sun's north or south point, of the point of First Contact at which the moon will first indent the Sun's disk. The dashed lines B60R to B30R show the position angles of the same point of First Contact as counted from the bottom or lowest point of the Sun towards the right.

* Read at the Albany meeting of the American Astronomical Society. Aug. 31, 1917.

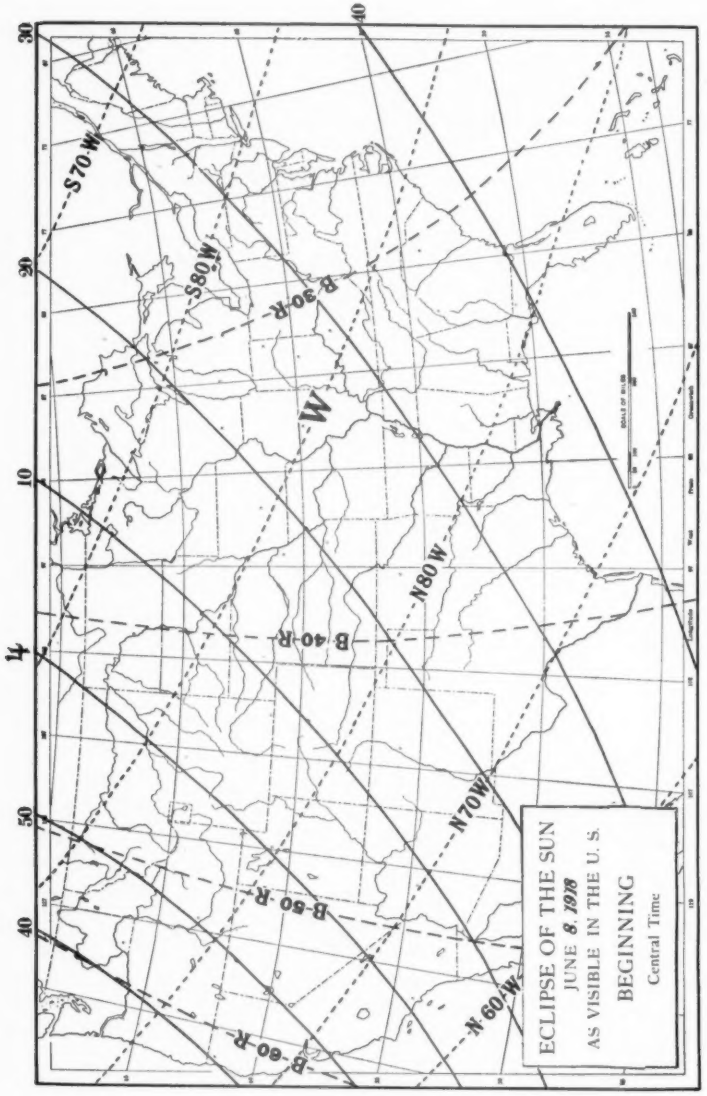

ECLIPSE OF THE SUN
JUNE 8, 1918
AS VISIBLE IN THE U. S.
BEGINNING
Central Time
S 70 W
S 80 W
B 30 R
M
N 80 W
B 40 R
N 70 W
B 50 R
N 60 W
B 60 R
B 60 R
30
40
50
10
20
40

FIGURE 1.

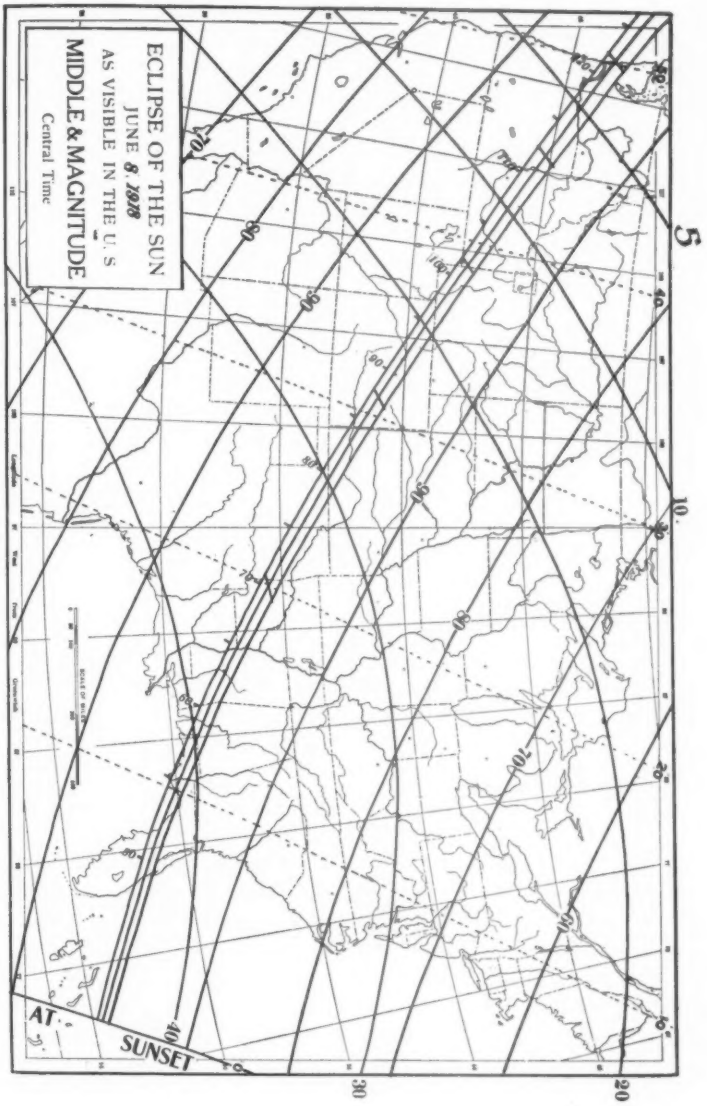

ECLIPSE OF THE SUN
JUNE 8, 1918
AS VISIBLE IN THE U. S.
MIDDLE & MAGNITUDE
Central Time
AT SUNSET
5
10
20
30

FIGURE 2.

Figure 2 contains the data pertaining to the greatest magnitude attained by the eclipse. The large 5 on top of the map and near its left, means 5 o'clock, Central time, and the 10 to the right of the 5, the 20, 30, 40 on the right border mean the minutes after 5 o'clock. The three close parallel curves denote the path of totality. The numbers from 120 to 50 along its southern border indicate the seconds that the total phase will last. The dotted lines 0, 10, 20 30, 40, 50, show the Sun's altitude at the time. The curves marked 90, 80, 70, 60, on either side of the central line, show the percentage of the obscuration. Figure 3 shows the corresponding appearance of the sun.

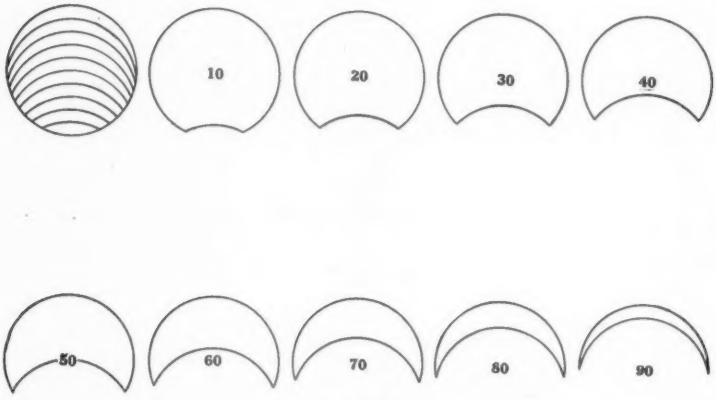


FIGURE 3.

Figure 4 pertains to the end of the eclipse. The full lines marked 10, 20, 30, 40, on the left border of the map mean the minutes after 6 o'clock, Central time. The dotted curves S60E—E show the position angles of the point of Last Contact as measured from the Sun's south point towards the east. The dashed curves T 80 L—T 20 L show the position angles measured from the top or uppermost point of the Sun towards the left. To the east of the curve marked "Eclipse ends at Sunset" the Sun will set before the eclipse is over. And finally the curves marked 10, 9, 8, 7, 6, on the upper border, indicate the full hours of the Central times of sunset.

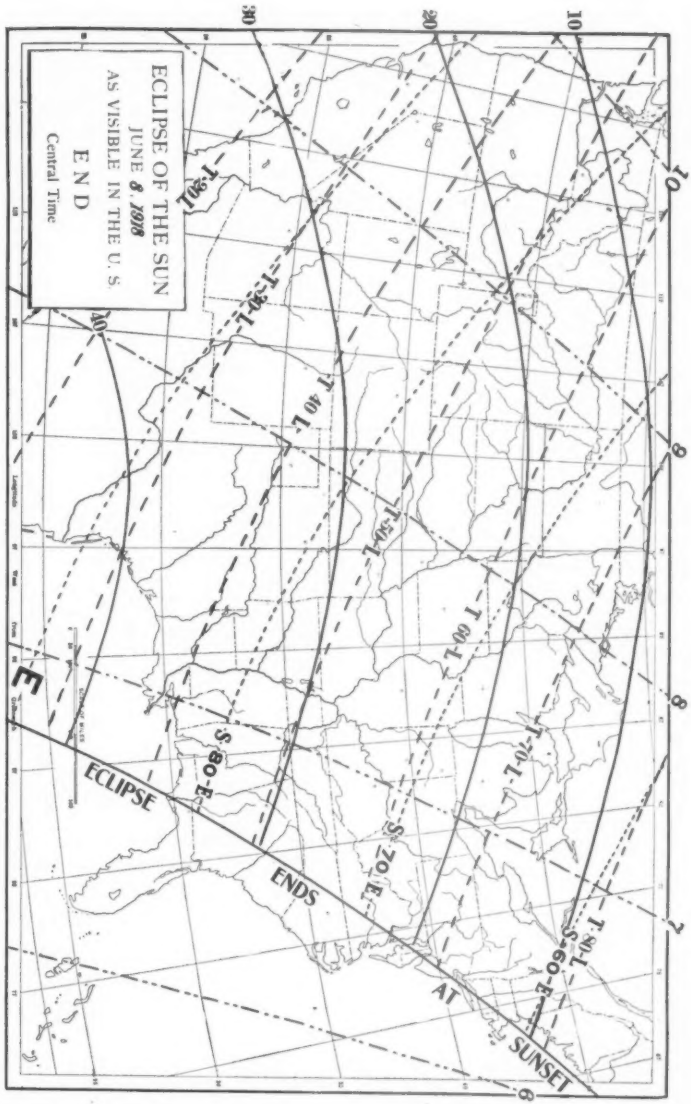

ECLIPSE OF THE SUN
JUNE 8, 1918
AS VISIBLE IN THE U. S.
E N D
Central Time
ECLIPSE
ENDS
AT
SUNSET
T 30 L
T 40 L
T 50 L
T 60 L
T 70 L
T 80 L
S 80 E
S 70 E
S 60 E
30
20
10
40
10
9
8
8
7
9

FIGURE 4.

JUPITER.

"King of gods and of men."

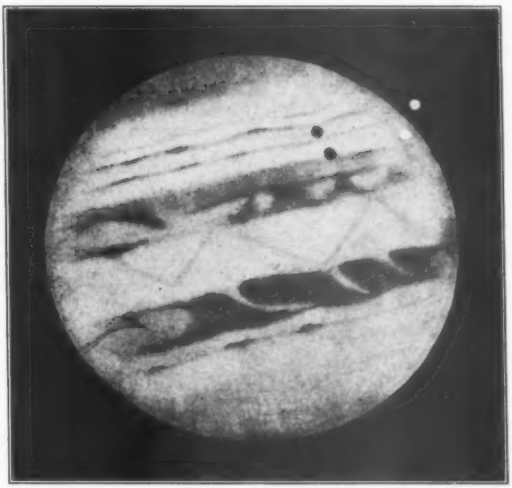
(A translation by Charles Nevers Holmes from an article on the planet Jupiter by the famous astronomer, Camille Flammarion, in *L'Astronomie*, January 1917.)

If radiant Venus is the star of the evening and the morning, the white goddess of love and beauty; if Mars with the red rays personifies war; if Mercury, which flies alternately and swiftly on all sides of the Sun, is indeed a messenger of Apollo; if Saturn, whose revolution, long and slow, of thirty terrestrial years, at the frontiers of the ancient system of the world, is the god of Time and Destiny; Jupiter, the planet of the ecliptic, who reigns in his royal route, is particularly the dominant star of the starry procession of night, and the discoveries of modern astronomy have not at all diminished the interest which he was able to offer to our ancestors in the time of Fable and Astrology. Here again, as everywhere, reality is superior to illusion.

The mere fact of knowing that this dazzling luminous point is a globe similar to that which we inhabit, without light of its own, illumined by the same sun as ourselves, shining by the reflection of this illumination, surrounded by a procession of satellites in which four moving moons are constantly visible through the simplest instruments, covered by clouds and fluid currents, whose fantastic motion observation is at present following, presenting a disc of a diameter eleven times superior to that of the earth and a volume thirteen hundred times greater than our world's; the fact of knowing also that there is there an earth in the sky, in its primordial cosmogonic phase, recalling to mind the terrestrial genesis millions of years ago, and showing us the world of the future whose reign will come at an epoch in which our mankind will without doubt have drawn its last breath; the fact, say I, of seeing there a gigantic world, soaring to 600 millions of kilometers from here, which transports us all at once to the bosom of the mysteries of space and time, cannot fail to arouse in the very dullest mind, in the most indifferent observer, a spark of curiosity which is worth by itself the reading of the more stirring fiction by our visionary writers. For there is there a reality, a tremendous reality, a summary, so to speak, of the whole entire cosmos: the present for us who observe it, the past for the youth of the earth, the future for the future ages.

It is an ancient sun, hardly lifeless, which has lost its light, but not its heat, only a thousand times smaller than the star of day, intermediate in its greatness between the solar and the terrestrial globe. It

weighs 318 times more than the earth, and gravity at its surface is 2½ times greater than here; a kilogram there weighs 2,530 grams and a human being weighing here 70 kilos would weigh there 178. But because of the vast volume of this Jovian globe, its density is only a quarter of that of the terrestrial materials. It is a world of fluids and of more or less dense gas; its density is scarcely superior to that of water.



THE PLANET JUPITER,
1295 times as large as the Earth.
Passage of the two satellites Io and Europa before the planet, producing two total eclipses of the Sun (Oct. 6, 1916).
Drawing by M. Mentore Maggini, in *L'Astronomie.*

It turns very rapidly upon its axis, more than twice as rapidly as the earth, for instead of 24 hours, the daily rotation is performed in less than 10 hours. An observation that strikes us with astonishment is that this enormous globe does not turn wholly in one piece, but by different zones themselves variable: at the equator in 9 hours 50 minutes, above the tropics in 9 hours 55 minutes, elsewhere with a still different velocity, and since the year of Jupiter is twelve times longer than ours, the jovian year numbers more than ten thousand days for every year, and 87 days more in the latitude of Bogota, for example, than in that of Cairo.

Its constant observation is of permanent interest and ever varied. Its famous reddish spot, a floating island vaster than the earth, a continent

in formation perhaps, has paled much for some time, and its fluctuations as well as its aspects are subject to the influence of a subtropical current which alternately attracts and repels it. The whole surface of the planet gives the impression of clouds parallel to the equator, arranged in bands changeable from one day to another, and indeed from one hour to another. We have taken of it a large number of drawings during the recent opposition at the Observatory of Juvisy, and we have received some excellent ones from various observers. Among these, we point out particularly to the notice of our readers the magnificent sketch made at the Observatory of Florence on the 6th of October last, by M. Mentore Maggini, at an hour in which the first and the second satellites, Io and Europa, were arriving on the vast disc, while casting their shadows, the former *gray*, the other *black*. There was there a most curious spectacle for the observer. By a happy coincidence, at the time that M. Maggini was making this observation at Florence, Mlle Renaudot was making the same at Juvisy (20^h 30^m central Europe time).

During their crossing of the immense disc, the shadow of the first satellite was cast upon the middle southern zone, and that of the second on the tropical zone. There were then at the same moment, that day, two total solar eclipses on Jupiter for both zones parallel with the southern hemisphere, a phenomenon impossible on the earth, with its single moon, whereas Jupiter possesses a magnificent retinue of nine satellites.

Whereas the first satellite remained visible during the entire duration of its passage before the planet, the second satellite disappeared almost immediately after its arrival at the following edge, only to reappear almost two hours and a half later on the preceding border.

This vast world is in its primordial period and is preparing itself for the future. Spectrum analysis shows that the substances which predominate there are different from terrestrial substances. We can imagine that the living beings who develop there will be chemically different from terrestrial beings, composed not of oxygen, hydrogen, carbon and nitrogen, but of other combinations. It is a world heterogeneous to us.

We do not observe it with less of interest for that. The mind that thinks understands that our present epoch has not a special importance, that it has been preceded by other epochs and that it will be followed by unknown cycles. It is not because we exist at this moment that time would be able to be estimated as having more value. The years contemporary with Jesus Christ or with the Pharaohs who built the pyramids have as much value as ours, and when we shall be no more, the earth will continue to turn and to regulate other days for our

successors the length of eternal life. Whether Jupiter may be inhabited in this year or in five hundred years, or in ten millions of years, is the same vision before the eye of the philosopher. Everything is present in this aspect, the future as well as the past.

Let us hail in Jupiter the symbol of the future. Behind him, in the constellations, there are some stars whose light, departing at the time of the Trojan war, reaches us only today. Thus, in the same book of the sky, the past and the future are united and tell us that, if there is anything interesting in human life, it is the thought, it is the mind that contemplates the universe, which lives intellectually, and without which all nature would be only the sport of an unconscious automaton. We have said it more than once, and we shall not be able too much to repeat it, especially on commencing this new year in which it seems that brutal matter crushes all the nobleness of the mind.

Newton, Mass.
41 Arlington St.

DATA FOR THE TOTAL SOLAR ECLIPSE OF JUNE 8, 1918.

FLORENCE DELL STOUDER.

Parties intending to observe the total solar eclipse of June 8, 1918, will desire to know the latitudes and longitudes of points on the central line, and also on the limiting lines. On p. 561 of the *American Ephemeris* for 1918 are given these data for each five minutes of Greenwich mean time. The tabulated values vary so rapidly that accurate results cannot be obtained from this table without using orders of differences which are higher than the first.

The Director of the Chamberlin Observatory of the University of Denver suggested that a series of values be computed by interpolation, having the intervals of the argument so small that all orders of differences above the first would become negligible. At first a table was constructed with an argument varying from minute to minute. As second differences were appreciable in this tabulation its data were used in computing the following table in which the argument interval is only ten seconds, and second differences are negligible. The states of Kansas, Colorado, Utah, Wyoming, Idaho, Oregon and Washington are served by the tabulated material.

As much of the shadow path in these states lies in mountainous country where local formations might have an influence on choosing the sites of stations, the altitude and azimuth of the sun, at points along the central line have been computed, with the Greenwich mean time of mid-totality as the argument. The azimuth is reckoned from the south point of the horizon westward; no refraction correction has been applied to the altitude. The coördinates were first computed to tenths of a minute, for five minute intervals of time; then interpolation was made for each minute of time, and finally the results were rounded off to the nearest minute of arc.

Portions of the computations involved in this article were checked by independent calculations executed by Miss Sara M. Jordan and Mr. Harold R. Baker.

Greenwich Mean Time			NORTHERN LIMIT				CENTRAL LINE				SOUTHERN LIMIT			
			North Latitude		West Longitude		North Latitude		West Longitude		North Latitude		West Longitude	
h	m	s	°	′	°	′	°	′	°	′	°	′	°	′
10	50	0	48	1.0	126	37.1	47	36.4	127	1.4	47	11.6	127	25.1
		10	47	59.4		31.1		34.8	126	55.4		10.1		19.2
		20		57.8		25.0		33.3		49.4		8.6		13.3
		30		56.2		19.0		31.7		43.5		7.0		7.4
		40		54.6		12.9		30.2		37.5		5.5		1.4
		50		53.0		6.0		28.6		31.5		3.9	126	55.5
	51	0	47	51.4	126	0.8	47	27.0	126	25.5	47	2.4	126	49.6
		10		49.8	125	54.7		25.4		19.5		0.8		43.7
		20		48.1		48.6		23.8		13.5	46	59.3		37.7
		30		46.5		42.6		22.2		7.5		57.7		31.8
		40		44.8		36.5		20.6		1.5		56.2		25.9
		50		43.2		30.4		19.0	125	55.5		54.6		19.9
	52	0	47	41.5	125	24.3	47	17.4	125	49.5	46	53.0	126	14.0
		10		39.8		18.2		15.8		43.5		51.4		8.0
		20		38.1		12.1		14.1		37.5		49.8		2.1
		30		36.4		6.1		12.5		31.5		48.2	125	56.2
		40		34.7		0.0		10.8		25.4		46.6		50.2
		50		33.0	124	53.9		9.2		19.4		45.0		44.2
	53	0	47	31.3	124	47.8	47	7.5	125	13.4	46	43.4	125	38.3
		10		29.6		41.7		5.8		7.4		41.8		32.4
		20		27.9		35.6		4.2		1.3		40.1		26.4
		30		26.1		29.6		2.5	124	55.3		38.5		20.5
		40		24.4		23.5		0.8		49.3		36.8		14.5
		50		22.6		17.4	46	59.1		43.2		35.2		8.6
	54	0	47	20.9	124	11.3	46	57.4	124	37.2	46	33.5	125	2.6
		10		19.1		5.2		55.7		31.2		31.8	124	56.6
		20		17.4	123	59.1		54.0		25.1		30.2		50.6
		30		15.6		53.0		52.2		19.1		28.5		44.7
		40		13.9		46.9		50.5		13.1		26.8		38.7
		50		12.1		40.7		48.8		7.0		25.1		32.7
	55	0	47	10.3	123	34.6	46	47.0	124	1.0	46	23.4	124	26.7
		10		8.5		28.5		45.2	123	54.9		21.7		20.7
		20		6.7		22.3		43.5		48.9		20.0		14.7
		30		4.9		16.2		41.7		42.8		18.2		8.7
		40		3.1		10.1		40.0		36.8		16.5		2.7
		50		1.2		3.9		38.2		30.7		14.8	123	56.7
	56	0	46	59.4	122	57.8	46	36.4	123	24.6	46	13.0	123	50.7
		10		57.6		51.7		34.6		18.5		11.2		44.7
		20		55.7		45.5		32.8		12.4		9.5		38.7
		30		53.8		39.4		31.0		6.4		7.7		32.7
		40		52.0		33.3		29.2		0.3		6.0		26.7
10	56	50		50.1		27.1		27.3	122	54.2		4.2		20.6

Greenwich Mean Time			NORTHERN LIMIT				CENTRAL LINE				SOUTHERN LIMIT			
			North Latitude		West Longitude		North Latitude		West Longitude		North Latitude		West Longitude	
h	m	s	°	′	°	′	°	′	°	′	°	′	°	′
10	57	0	46	48.2	122	21.0	46	25.5	122	48.1	46	2.4	123	14.6
		10		46.3		14.8		23.7		42.0		0.6		8.6
		20		44.4		8.7		21.8		35.9	45	58.8		2.5
		30		42.5		2.5		20.0		29.8		57.0	122	56.5
		40		40.6	121	56.4		18.1		23.7		55.2		50.4
		50		38.7		50.2		16.3		17.6		53.3		44.4
	58	0	46	36.8	121	44.0	46	14.4	122	11.5	45	51.5	122	38.3
		10		34.9		37.8		12.5		5.4		49.7		32.2
		20		32.9		31.6		10.6	121	59.3		47.8		26.2
		30		31.0		25.5		8.7		53.1		45.9		20.1
		40		29.0		19.3		6.8		47.0		44.1		14.0
		50		27.1		13.1		4.8		40.8		42.2		8.0
	59	0	46	25.1	121	6.9	46	2.9	121	34.7	45	40.3	122	1.9
		10		23.1		0.7		1.0		28.6		38.4	121	55.8
		20		21.1	120	54.5	45	59.0		22.4		36.5		49.7
		30		19.1		48.3		57.1		16.3		34.6		43.7
		40		17.1		42.1		55.1		10.1		32.7		37.6
		50		15.1		35.8		53.2		4.0		30.8		31.5
11	0	0	46	13.1	120	29.6	45	51.2	120	57.8	45	28.9	121	25.4
		10		11.1		23.4		49.2		51.6		27.0		19.3
		20		9.0		17.2		47.2		45.4		25.0		13.2
		30		7.0		10.9		45.2		39.3		23.1		7.1
		40		4.9		4.7		43.2		33.1		21.1		1.0
		50		2.9	119	58.4		41.2		26.9		19.2	120	54.8
	1	0	46	0.8	119	52.2	45	39.2	120	20.7	45	17.2	120	48.7
		10	45	58.7		45.9		37.2		14.5		15.2		42.6
		20		56.7		39.7		35.1		8.3		13.2		36.4
		30		54.6		33.4		33.1		2.1		11.2		30.3
		40		52.5		27.2		31.0	119	55.9		9.2		24.1
		50		50.4		20.9		29.0		49.7		7.2		18.0
	2	0	45	48.3	119	14.6	45	26.9	119	43.5	45	5.2	120	11.8
		10		46.2		8.3		24.8		37.3		3.2		5.6
		20		44.0		2.0		22.7		31.1		1.2	119	59.4
		30		41.9	118	55.7		20.6		24.8	44	59.1		53.3
		40		39.7		49.4		18.5		18.6		57.1		47.1
		50		37.6		43.1		16.4		12.3		55.0		40.9
	3	0	45	35.4	118	36.8	45	14.3	119	6.1	44	53.0	119	34.7
		10		33.2		30.5		12.2	118	59.9		50.9		28.5
		20		31.0		24.2		10.1		53.6		48.9		22.3
		30		28.8		17.9		7.9		47.3		46.8		16.1
		40		26.6		11.6		5.8		41.1		44.7		9.9
		50		24.4		5.2		3.7		34.8		42.6		3.6
	4	0	45	22.2	117	58.9	45	1.5	118	28.5	44	40.5	118	57.4
		10		20.0		52.5	44	59.3		22.2		38.4		51.2
		20		17.7		46.2		57.1		15.9		36.2		44.9
		30		15.5		39.8		54.9		9.6		34.1		38.7
		40		13.2		33.5		52.7		3.3		31.9		32.4
		50		11.0		27.1		50.5	117	56.9		29.8		26.2
	5	0	45	8.7	117	20.7	44	48.3	117	50.6	44	27.6	118	19.9
		10		6.4		14.3		46.1		44.3		25.4		13.6
		20		4.1		7.9		43.9		37.9		23.2		7.3
		30		1.8		1.5		41.6		31.6		21.0		1.0
		40	44	59.5	116	55.1		39.4		25.2		18.8	117	54.7
		50		57.1		48.7		37.1		18.9		16.6		48.4
	6	0	44	54.8	116	42.3	44	34.9	117	12.5	44	14.4	117	42.1
		10		52.5		35.9		32.6		6.1		12.2		35.8
		20		50.1		29.4		30.3	116	59.8		10.0		29.5
		30		47.8		23.0		28.0		53.4		7.7		23.1
		40		45.4		16.5		25.7		47.0		5.5		16.8
11	6	50		43.1		10.1		23.4		46.6		3.2		10.5

Greenwich Mean Time			NORTHERN LIMIT				CENTRAL LINE				SOUTHERN LIMIT			
			North Latitude		West Longitude		North Latitude		West Longitude		North Latitude		West Longitude	
h	m	s	°	′	°	′	°	′	°	′	°	′	°	′
11	7	0	44	40.7	116	3.6	44	21.1	116	34.2	44	1.0	117	4.1
		10		38.3	115	57.1		18.8		27.8	43	58.7	116	57.7
		20		36.0		50.7		16.4		21.4		56.4		51.4
		30		33.6		44.2		14.1		14.9		54.1		45.0
		40		31.2		37.7		11.7		8.5		51.8		38.6
		50		28.8		31.2		9.4		2.0		49.5		32.2
	8	0	44	26.4	115	24.7	44	7.0	115	55.6	43	47.2	116	25.8
		10		24.0		18.2		4.6		49.1		44.8		19.4
		20		21.5		11.7		2.2		42.7		42.5		13.0
		30		19.1		5.1	43	59.8		36.2		40.1		6.5
		40		16.6	114	58.6		57.4		29.7		37.8		0.1
		50		14.1		52.1		55.0		23.2		35.4	115	53.6
	9	0	44	11.6	114	45.5	43	52.6	115	16.7	43	33.0	115	47.2
		10		9.1		38.9		50.2		10.2		30.6		40.7
		20		6.6		32.4		47.7		3.7		28.2		34.3
		30		4.0		25.8		45.2	114	57.1		25.8		27.8
		40		1.5		19.2		42.8		50.6		23.4		21.3
		50	43	59.0		12.6		40.3		44.1		21.0		14.8
	10	0	43	56.4	114	6.0	43	37.8	114	37.5	43	18.6	115	8.3
		10		53.8	113	59.4		35.3		30.9		16.2		1.8
		20		51.3		52.8		32.8		24.3		13.7	114	55.3
		30		48.7		46.2		30.2		17.7		11.2		48.7
		40		46.1		39.5		27.7		11.1		8.8		42.2
		50		43.5		32.9		25.2		4.5		6.3		35.7
	11	0	43	40.9	113	26.2	43	22.6	113	57.9	43	3.8	114	29.1
		10		38.3		19.5		20.0		51.3		1.3		22.5
		20		35.6		12.8		17.5		44.6	42	58.8		15.9
		30		33.0		6.1		14.9		38.0		56.3		9.3
		40		30.3	112	59.4		12.3		31.3		53.8		2.7
		50		27.7		52.6		9.7		24.7		51.2	113	56.1
	12	0	43	25.0	112	45.9	43	7.1	113	18.0	42	48.7	113	49.4
		10		22.3		39.2		4.5		11.3		46.1		42.8
		20		19.6		32.4		1.8		4.6		43.6		36.1
		30		16.9		25.7	42	59.2	112	57.9		41.0		29.4
		40		14.2		18.9		56.5		51.2		38.4		22.8
		50		11.4		12.2		53.9		44.4		35.8		16.1
	13	0	43	8.7	112	5.4	42	51.2	112	37.7	42	33.2	113	9.4
		10		5.9	111	58.6		48.5		30.9		30.6		2.7
		20		3.2		51.8		45.8		24.2		27.9	112	56.0
		30		0.4		45.0		43.1		17.4		25.3		49.3
		40	42	57.7		38.1		40.4		10.6		22.6		42.5
		50		54.9		31.3		37.6		3.8		20.0		35.8
	14	0	42	52.1	111	24.4	42	34.9	111	57.0	42	17.3	112	29.0
		10		49.3		17.5		32.1		50.2		14.6		22.2
		20		46.5		10.6		29.4		43.3		11.9		15.4
		30		43.7		3.7		26.6		36.5		9.2		8.6
		40		40.8	110	56.8		23.8		29.6		6.5		1.8
		50		38.0		49.8		21.0		22.7		3.7	111	55.0
	15	0	42	35.1	110	42.9	42	18.2	111	15.8	42	1.0	111	48.1
		10		32.2		36.0		15.4		8.9	41	58.2		41.2
		20		29.3		29.0		12.5		2.0		55.5		34.4
		30		26.4		22.1		9.7	110	55.0		52.7		27.5
		40		23.5		15.1		6.8		48.1		49.9		20.6
		50		20.5		8.1		4.0		41.1		47.1		13.6
	16	0	42	17.6	110	1.0	42	1.1	110	34.1	41	44.3	111	6.7
		10		14.6	109	54.0	41	58.2		27.1		41.5	110	59.8
		20		11.7		46.9		55.3		20.1		38.6		52.8
		30		8.7		39.8		52.4		13.1		35.8		45.8
		40		5.7		32.7		49.5		6.0		32.9		38.8
11	16	50		2.7		25.6		46.5	109	59.0		30.0		31.8

Greenwich Mean Time			NORTHERN LIMIT North Latitude		West Longitude		CENTRAL LINE North Latitude		West Longitude		SOUTHERN LIMIT North Latitude		West Longitude	
h	m	s	°	′	°	′	°	′	°	′	°	′	°	′
11	17	0	41	59.7	109	18.5	41	43.6	109	51.9	41	27.1	110	24.8
		10		56.7		11.4		40.6		44.8		24.2		17.8
		20		53.6		4.2		37.6		37.7		21.3		10.7
		30		50.5	108	57.0		34.6		30.6		18.4		3.6
		40		47.4		49.8		31.6		23.5		15.5	109	56.5
		50		44.3		42.6		28.6		16.4		12.5		49.4
	18	0	41	41.2	108	35.4	41	25.6	109	9.2	41	9.5	109	42.3
		10		38.1		28.2		22.6		2.0		6.5		35.2
		20		35.0		20.9		19.5	108	54.8		3.5		28.1
		30		31.8		13.6		16.4		47.6		0.5		20.9
		40		28.6		6.3		13.3		40.4	40	57.5		13.7
		50		25.5	107	59.0		10.2		33.1		54.5		6.5
	19	0	41	22.3	107	51.7	41	7.1	108	25.8	40	51.4	108	59.3
		10		19.1		44.4		4.0		18.5		48.3		52.1
		20		15.9		37.0		0.9		11.2		45.3		44.8
		30		12.7		29.6	40	57.7		3.9		42.2		37.5
		40		9.4		22.2		54.5	107	56.5		39.1		30.2
		50		6.2		14.8		51.3		49.1		35.9		22.9
	20	0	41	2.9	107	7.4	40	48.1	107	41.7	40	32.8	108	15.5
		10	40	59.6		0.0		44.9		34.3		29.6		8.2
		20		56.3	106	52.5		41.7		26.9		26.5		0.8
		30		53.0		45.0		38.4		19.4		23.3	107	53.4
		40		49.6		37.5		35.1		11.9		20.1		46.0
		50		46.3		30.0		31.9		4.4		16.8		38.6
	21	0	40	42.9	106	22.4	40	28.6	106	56.9	40	13.6	107	31.1
		10		39.5		14.8		25.3		49.4		10.4		23.6
		20		36.1		7.2		22.0		41.8		7.1		16.1
		30		32.7	105	59.5		18.7		34.2		3.9		8.5
		40		29.3		51.8		15.3		26.6		0.6		0.9
		50		25.9		44.1		12.0		19.0	39	57.3	106	53.3
	22	0	40	22.4	105	36.4	40	8.6	106	11.3	39	54.0	106	45.7
		10		18.9		28.7		5.2		3.6		50.7		38.1
		20		15.4		20.9		1.8	105	55.9		47.3		30.4
		30		11.9		13.1	39	58.4		48.2		44.0		22.8
		40		8.4		5.3		54.9		40.4		40.6		15.1
		50		4.8	104	57.5		51.4		32.6		37.2		7.3
	23	0	40	1.2	104	49.6	39	47.9	105	24.8	39	33.8	105	59.6
		10	39	57.6		41.7		44.4		17.0		30.4		51.8
		20		54.0		33.8		40.9		9.1		26.9		44.0
		30		50.3		25.9		37.3		1.2		23.5		36.2
		40		46.7		17.9		33.7	104	53.3		20.0		28.3
		50		43.0		9.9		30.1		45.4		16.5		20.4
	24	0	39	39.3	104	1.9	39	26.5	104	37.4	39	13.0	105	12.5
		10		35.6	103	53.8		22.9		29.4		9.5		4.5
		20		31.9		45.7		19.2		21.3		5.9	104	56.5
		30		28.1		37.5		15.5		13.2		2.4		48.5
		40		24.4		29.3		11.8		5.1	38	58.8		40.5
		50		20.6		21.1		8.1	103	57.0		55.2		32.4
	25	0	39	16.8	103	12.9	39	4.4	103	48.8	38	51.6	104	24.3
		10		13.0		4.7		0.6		40.6		48.0		16.2
		20		9.1	102	56.4	38	56.9		32.4		44.3		8.0
		30		5.2		48.1		53.1		24.2		40.6	103	59.8
		40		1.3		39.7		49.3		15.9		36.9		51.6
		50	38	57.4		31.3		45.4		7.6		33.2		43.3
	26	0	38	53.5	102	22.9	38	41.6	102	59.2	38	29.5	103	35.0
		10		49.5		14.4		37.7		50.8		25.7		26.7
		20		45.6		5.9		33.9		42.4		22.0		18.3
		30		41.6	101	57.4		30.0		33.9		18.2		9.9
		40		37.5		48.8		26.0		25.4		14.3		1.4
11	26	50		33.5		40.2		22.1		16.8		10.5	102	52.9

Greenwich Mean Time			NORTHERN LIMIT North Latitude		NORTHERN LIMIT West Longitude		CENTRAL LINE North Latitude		CENTRAL LINE West Longitude		SOUTHERN LIMIT North Latitude		SOUTHERN LIMIT West Longitude	
h	m	s	°	′	°	′	°	′	°	′	°	′	°	′
11	27	0	38	29.4	101	31.5	38	18.1	102	8.2	38	6,6	102	44.4
		10		25.3		22.8		14.1	101	59.6		2.7		35.8
		20		21.2		14.0		10.1		50.9	37	58.8		27.2
		30		17.0		5.2		6.0		42.2		54.8		18.5
		40		12.8	100	56.4		1.9		33.4		50.8		9.8
		50		8.6		47.5	37	57.8		24.6		46.8		1.1
	28	0	38	4.4	100	38.6	37	53.7	101	15.7	37	42.8	101	52.3
		10		0.1		29.6		49.6		6.8		38.8		43.5
		20	37	55.9		20.6		45.4	100	57.9		34.7		34.7
		30		51.6		11.6		41.2		48.9		30.6		25.8
		40		47.2		2.5		37.0		39.9		26.5		16.8
		50		42.9	99	53.4		32.7		30.8		22.4		7.8
	29	0	37	38.5	99	44.2	37	28.4	100	21.7	37	18.2	100	58.8
		10		34.1		35.0		24.1		12.5		14.0		49.7
		20		29.7		25.6		19.8		3.3		9.8		40.6
		30		25.2		16.2		15.4	99	54.0		5.5		31.4
		40		20.7		6.8		11.0		44.7		1.2		22.1
		50		16.2	98	57.3		6.6		35.3	36	56.8		12.8
11	30	0	37	11.7	98	47.8	37	2.2	99	25.9	36	52.4	100	3.4

Greenwich Mean Time			Sun's Altitude		Sun's Azimuth	
h	m	s	°	′	°	′
10	55	0	50	0	67	16
	56	0	49	31	68	21
	57	0	49	2	69	25
	58	0	48	33	70	28
	59	0	48	2	71	31
11	0	0	47	32	72	33
	1	0	47	0	73	34
	2	0	46	29	74	34
	3	0	45	56	75	34
	4	0	45	23	76	33
	5	0	44	50	77	32
	6	0	44	16	78	30
	7	0	43	41	79	28
	8	0	43	6	80	24
	9	0	42	30	81	21
	10	0	41	53	82	17
	11	0	41	16	82	12
	12	0	40	38	84	7
	13	0	39	59	85	1
11	14	0	39	19	85	55

Greenwich Mean Time			Sun's Altitude		Sun's Azimuth	
h	m	s	°	′	°	′
11	15	0	38	39	86	49
	16	0	37	58	28	42
	17	0	37	16	88	34
	18	0	36	33	89	27
	19	0	35	49	90	19
	20	0	35	4	91	11
	21	0	34	18	92	2
	22	0	33	32	92	54
	23	0	32	43	93	45
	24	0	31	54	94	36
	25	0	31	3	95	27
	26	0	30	10	96	18
	27	0	29	17	97	9
	28	0	28	21	98	0
	29	0	27	23	98	51
	30	0	26	23	99	43
	31	0	25	22	100	34
	32	0	24	18	101	26
	33	0	23	10	102	19
	34	0	21	58	103	13
11	35	0	20	40	104	8

THE PLEIADES.

Where at night the eye of Taurus glitters with a ruddy glare
Where by day in May our sun shines o'er a newborn earth and air,
When a white resplendent mantle rests on barren glade and glen,
And grand Sirius is beaming over northern homes of men;
Like some small and distant beacons blazing 'mid the dome of night
Or some tiny jewels sparkling with a clear and crystal light,
Like a group of star-kings reigning on a firmamental throne,
Gleam the Pleiades of winter, silver-spangled and alone.

CHARLES NEVERS HOLMES.

Newton, Mass.
41 Arlington St.

A STRANGE PROBLEM IN THE CHEMISTRY OF THE HEAVENS. THE CEPHEIDS, STARS OF VARIABLE SPECTRA.

(A translation by Allan B. Burbeck of an article by G. Renaudot in *L'Astronomie*, March, 1917.)

August 13, 1596, the variation of the light from a star was noticed by the human eye for the first time. Up to that time, man had never doubted the unchangeableness of the light of the stars nor the sun.

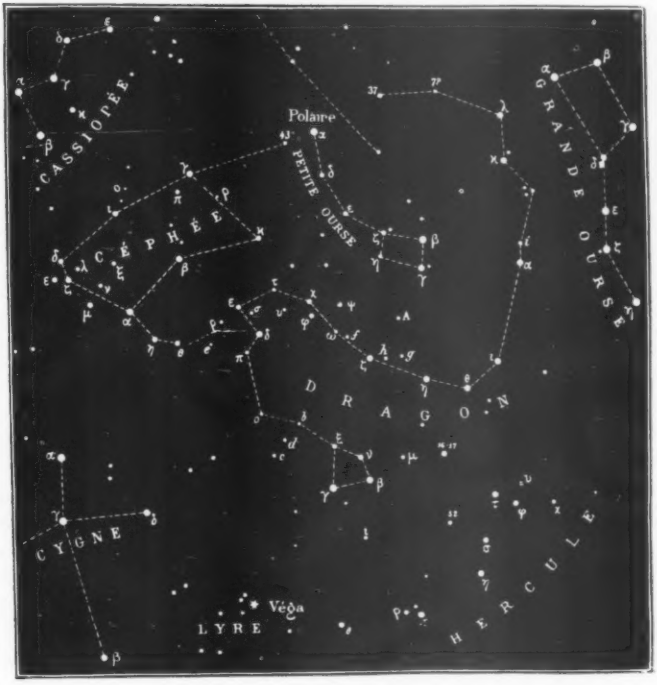


FIG. 1. The Constellations near the Pole and the star δ Cephei, type of irregular variables which have received the name Cepheids.

But in this remote month of August at the end of the sixteenth century, a careful observer, an unassuming clergyman, David Fabricius, noticed a star of the third magnitude in the constellation Cetus which did not appear on any of the maps of that period.

This star worshiper, astronomer and astrologer(1) followed this curious star for two months, but in October it disappeared. In 1603, Bayer designated it on his Atlas (it was at that time of the fourth magnitude) and gave it the letter omicron. Since then it has been followed regularly. Thirty-five years later, Holwarda observed it during an eclipse of the moon, its light then being brighter than the third magnitude. Searching for it during the summer of 1639, this astronomer was unable to find any trace of it, but he saw it again on the seventh of the following November in its old place. This was the discovery of the first variable star, which is none other than Mira Ceti, "the wonderful star of the Whale." (2)

Beginning from this period, other stars were recognized as possessing stages of fluctuating light. Nevertheless at the end of the seventeenth century, there were only four known, and only eleven at the end of the eighteenth century. *L'Annuaire Astronomique* (Flammarion) gives the dates of discovery of these eleven variables.

Mira Ceti	1596	β Lyrae	1784
Algol	1669	δ Cephei	1784
R Hydrae	1670	R Coronae Borealis	1795
χ Cygni	1686	α Herculis	1795
R Leonis	1782	R Scuti	1795
η Aquilae	1784		

In the middle of the next century, only thirty variable stars were known. Today they are counted in thousands. If we wish to establish a classification of them all, we must first state that 90 out of every 100 of these thousands of stars, of which the light undergoes fluctuations, must be placed in three well defined groups.

First. Stars of fleeting eclipses, of the Algol type, which, remaining at steady brightness, undergo very regularly a temporary extinction, more or less intense, being the result of the transit of a companion, more or less dark, before the principal star, and depending upon the inclination angle of the plane in which it revolves around it. The period of their variation ranges from a few hours to a year or more, following the extent of the orbit traveled over by the secondary star, and the variation of light may be less than one-tenth or it may attain several magnitudes, depending upon whether the eclipse is nearly total or only partial. These systems move nearly in our line of sight.

Second. Stars of long period, from six months to two years, which show usually a strong red color and of which the fluctuation of light is large. Type Mira Ceti.

Third. Stars of short period, from twelve hours to fifty days, in which the variation is usually about one magnitude; with maxima and minima often doubled, in which the increase in brightness is generally more rapid than the decrease, and in which the fluctuations are

irregular. Of these three divisions this class contains the most stars. It has for its type delta Cephei, the eighth variable recognized by astronomers; its variations present particular characteristics which distinguish it from the others. It is for this reason the name Cepheids has been given to the stars bestowed with similar characteristics. Actually more than half of the many catalogued variables fall into this very important group.

Our readers will find at the head of this article the map showing the position of this star, taken from the works of Flammarion, *Les Etoiles*, in which the author has, among other things, taken especial care to call to the attention the particular interest in this remote sun. ([3])

What are, therefore, the particular characteristics of this star delta Cephei?

A century after its variations in brightness were discovered, variations in its radial velocity were also disclosed. It was the sixth spectroscopic variable star in which this characteristic was proven, but this sort of variation is moreover of a peculiar type in this star, for, if the variation in the spectral type is identical with that of the change in brightness, then the orbital elements, deduced according to the hypothesis due exclusively to the movements of a double star, do not furnish any satisfactory explanation for the singularities of the light fluctuations.

Lastly—and this is perhaps the most peculiar characteristic of this type of star,—the spectrum of delta Cephei shows variations which reach eight divisions in the Harvard classification, ([4]) from F4 at maximum to G2 at minimum. The spectral type, designated by the letter F in the Draper Catalogue, forms an intermediate group between Secchi's first type, including white hydrogen stars and his second type, which includes yellow stars showing a spectrum like that of our sun. The rapid progress in Chemistry of the Heavens has made it necessary to adopt a more extended classification than that of Secchi. The first seventeen letters of the alphabet, from A to Q, are used in the new system to denote the different types of stellar spectra. Further subdivisions are also used, according to the greater or less intensity of the spectral lines and their number. These subdivisions are indicated by a number to the right of the type letter. G2 applies to a variety of Secchi's second type which in the Draper Catalogue goes from G to L, his first type extending from A to D.

Thus, as can be seen in Figure 2, which shows the light curve with the corresponding variations in the spectrum of delta Cephei, this star passes through the subdivisions of F type toward its maximum and through the many subdivisions of type G toward its minimum. ([5])

Such spectral changes are, naturally, accompanied by changes in the color of the star, enormous variations in its temperature and deep

modifications in its chemical state. They show, in these gigantic stellar crucibles, tremendous perturbations, which in a very short time

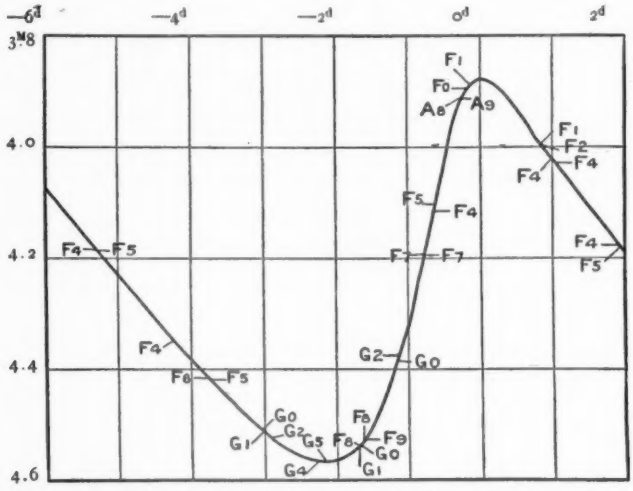


FIG. 2. Oscillations of Light and corresponding Variations of Spectrum of δ Cephei, from *Astrophysical Journal* Vol. XLIV, No. 5.

exhibit in the star characteristics by which astronomical classifications sum up actual knowledge and they represent the different stages of evolution attributed to the stars in their successive metamorphoses throughout the thousands of centuries.

Two photographs of the spectrum of delta Cephei taken by Shapley at Mt. Wilson, during the nights of December 23 and 24, 1915, the first near the maximum of light from the star and the second toward its minimum (Cassegrain spectrograph of three prisms and telescope of 1.52 meters), give the following results:

	Maximum	Minimum
Hydrogen line Hγ	Strong	Very weak
Heavy lines Fe, Ti, Sr and Cr	Strong	Very weak
λ 4481 Mg heavy	Very strong	Very weak
λ 4427 calcium	Strong	Intensified
Low temperature lines of Ca, Fe, Ti and Cr	Weak	Intensified
Continuous spectrum	Strong in the violet	Weak in the violet.

At the time of maximum, the lines corresponding to high temperatures are, accordingly, very intense, and those which correspond to low temperatures are, on the other hand, weak. When at minimum the

opposite phenomena are observed. This condition indicates that the gases contained in the star are at much higher temperature when the star is at maximum than when at minimum. (6)

.....

The great interest offered by these curious variable stars has induced many American astronomers, notably Adams, Seares, Pease and especially Shapley, to give them very deep study. Much work has been accomplished at Lick, Harvard and Pulkowa Observatories. At Mount Wilson, Shapley, following out his investigations in the same way, has found a score of stars of variable spectra of the delta Cephei type. (5) The following table gives the List:

Designation	R. A. 1900	Dec. 1900	Visual light Max. Magnitude	Range	Period days	Variation in Spectrum
	h m	° ′				
TU Cassiopeiae	0 20.9	+50 44	7.2	1.4	2.139	F1 to F8
SU Cassiopeiae	2 43.0	+68 28	5.9	0.4	1.950	A8 to F5
SZ Tauri	4 31.4	+18 20	7.2	0.5	3.149	A9 to F7
T Monocerotis	6 19.8	+ 7 8	5.5	1.1	27.012	F5 to G2
RT Aurigae	6 22.1	+30 34	5.1	0.9	3.728	A7 to G1
W Geminorum	6 29.2	+15 24	6.7	0.8	7.916	F2 to G1
RS Boötis	14 29.2	+32 11	9.2	1.0	0.377	B8 to F0
X Sagittarii	17 41.3	−27 48	4.4	0.6	7.012	F1 to G5
Y Ophiuchi	17 47.3	− 6 7	6.1	0.4	17.113	F5 to G3
W Sagittarii	17 58.6	−29 35	4.3	0.8	7.595	A8 to G2
Y Sagittarii	18 15.5	−18 54	5.4	0.8	5.773	F4 to G4
RR Lyrae	19 22.3	+42 36	6.8	0.9	0.567	B9 to F2
U Aquilae	19 24.0	− 7 15	6.2	0.7	7.024	F6 to G2
XZ Cygni	19 30.4	+56 10	8.7	0.6	0.467	A0 to A6
U Vulpeculae	19 32.3	+20 7	6.5	1.1	7.990	F7 to G5
SU Cygni	19 40.8	+29 1	6.2	0.8	3.846	A6 to F7
η Aquilae	19 47.4	+ 0 45	3.7	0.8	7.176	A8 to G5
S Sagittae	19 51.5	+16 22	5.5	0.6	8.382	F4 to G3
T Vulpeculae	20 47.2	+27 52	5.5	0.6	4.436	A9 to G1
δ Cephei	22 25.4	+57 54	3.5	0.8	5.366	F0 to G2

These variables are situated in certain regions of the Heavens bordering on the Milky Way. Of these twenty stars shown in this table, half of which are naked eye stars, some are located near the solar apex and the others are grouped near the antapex.

One of the most recent studies given these interesting variables by Shapley concerns RR Lyrae. The fluctuations in brightness of this star were discovered in July, 1899, by Miss Fleming at Harvard, by the following method. An exposure of many hours on the celestial field where the star to be studied is found is interrupted for some seconds every half hour, by means of a automatic catch which stops the clock movement, thus permitting the stars by reason of their apparent displacement to be photographed on other places on the plate. The result is a series of images of the same star in a row, by which a variation of short period even of a slight change is easily disclosed.

The period of variation in the brightness of RR Lyrae is 13½ hours. It is of 6.8 magnitude at maximum and wanes nearly one magnitude to its minimum. The observations of Kiess at Lick and Shapley at Mount Wilson have revealed a very curious fact in this variation of

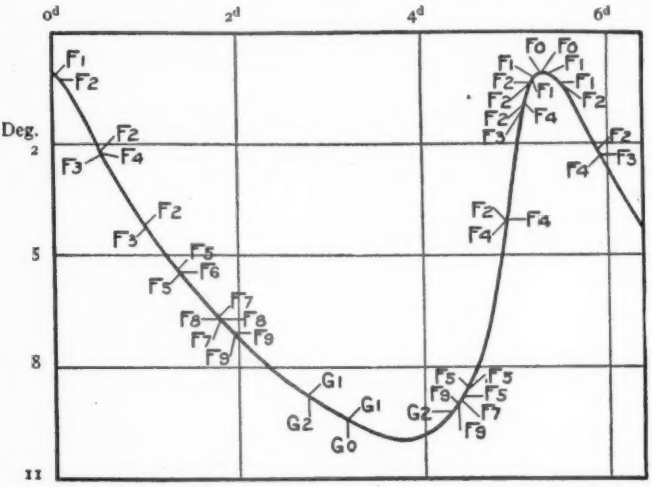


FIG. 3. Light Curve of η Aquilæ and Variations of its Spectrum, from *Astrophysical Journal* Vol. XLIV, No. 5.

light: During the 13½ hours, the light increases rapidly, more than doubling its intensity in less than two hours; at the same time the apparent radial speed of the star increases from 47 to 91 kilometers a second and the spectrum changes from F to A type. (A similar periodical variation of the spectrum of RS Boötis from type B8 to F0 has been found by Pease). The hypothesis, suggested by the variations of brightness and of radial speed, that the variable star revolves around a dark companion (although no trace of the secondary spectrum is found) meets the objection of the change in spectrum, in which is involved a change of temperature of the luminous surface amounting to 3000 degrees.

Moreover the variable length of time which the star takes to rise to its maximum and the irregularities in the form of the light curve are incompatible with a variation resulting from a uniform period and from a geometric cause.

On the two upper curves in Figure 4, which represent two maxima of RR Lyrae, separated by seven periods, the interval of time during which the star is brighter than the seventh magnitude is $1^h\ 55^m$ in the first and only 46^m in the second. On the two lower curves, traced by

Kiess at Lick, the interval during which the star is brighter than 7.3 magnitude is nearly twice as long for the first maximum as it is for the second (separated by seven periods). Furthermore the brightness

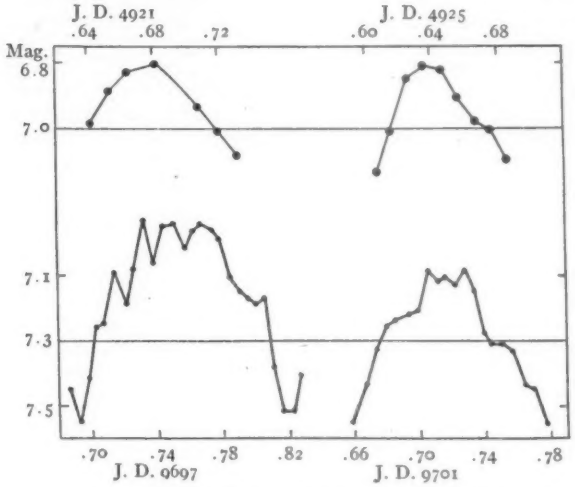


FIG. 4. Variations in the Form of Maxima of RR Lyræ, from *Astrophysical Journal* Vol. XLIII, No. 3.

of the two maxima differs 0.15 magnitude. The dates on this diagram are in Julian days and the hours are expressed in hundredths of a day.

Considering all these facts, Shapley has come to the conclusion that the characteristic variations of the Cepheids cannot be attributed to a geometric cause, as in the case of eclipses of double stars, but it is necessary to look for the cause in the different phenomena which may affect a gaseous mass, such as a collision or the close approach of two bodies, causing the ebbing and flowing of tides in the gaseous mass; the perturbations produced in it by an obscure companion; tremendous eruptions of gas at a higher temperature than that of the surface of the star, rushing from the interior toward the exterior with the constant shifting shown by the changes in the stellar spectrum. In every case, it would be the question of real changes in the physical and chemical states of the radiant surfaces.

Recently Martin and Plummer have come to a similar conclusion after studying RR Lyrae photographically and attribute the variations of this star to the pulsative action in its gaseous mass.

All these recent discoveries represent, it cannot be denied, a very important phase in Stellar Astronomy and also interesting in the

knowledge of our variable Star, the Sun, whose periodic activity, spots, protuberances, are manifestations similar to those, only infinitely less great.

BIBLIOGRAPHY: (1) David Fabricius, like Kepler and Tycho Brahé of whom he was a friend, and like most of the astronomers of his time, believed in Astrology. "He himself predicted from the stars, that May 7, 1617 would be fatal to him. That day, he took every possible precaution to prevent an accident. However, at ten in the evening believing himself out of danger, the idea came to him to walk in the presbytery court. Scarcely had he reached there than a peasant named John Hoyer, who believed himself pointed out in one of Fabricius' sermons as a thief, came forth from a place where he was hidden and with the blow of a pitchfork cleaved open the head of the unfortunate clergyman, who died the same night." (*Biographie Génerale de Hoefer*). Jean Fabricius his son, was the first to recognize solar spots, by the invention of the spy glass at the beginning of the seventeenth century. (2) and (8) See *Les Etoiles* by Flammarion. (4) *Proceedings of the National Academy of Sciences of the United States of America*, March 1916. (5) *Popular Astronomy* June-July 1916. (6) *Proceedings of the National Academy of Sciences of the United States of America*, March 1916. (7) Same April 1916. (8) *Astrophysical Journal*, December 1916. (9) *Contributions from the Mount Wilson Solar Observatory* No. 112: "On the changes in the spectrum, period and light curve of the Cepheid variable RR Lyrae" by Harlow Shapley.

TWENTY-FIRST MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY.

[*Continued from page 529.*]

THE OBLIQUITY OF THE ECLIPTIC FROM THE SUN OBSERVATIONS MADE AT THE U. S. NAVAL OBSERVATORY, 1903-1911.

BY W. S. EICHELBERGER.

Before discussing the observed declinations of the Sun to obtain the obliquity of the ecliptic, the following values of the personal equation of the observers were determined and applied to the observations:

PERSONAL EQUATION CORRECTIONS TO OBSERVED DECLINATION OF SUN'S CENTER.

Observer	Corr.	Observer	Corr.	Observer	Corr.
L	−0.″35	T	+0.″11	Bs	−0.″39
R	+0.18	Y	+0.13	P	−0.18
Br.	−0.13	Hl	−0.35	Fk	−0.52
M	+0.12				

After applying the personal equation corrections of the observers, the corrections to the ephemeris declinations of the Sun were divided into groups of about ten observations each, and the mean correction obtained for each group. These group means show a decided annual variation, the maximum correction occurring near the winter solstice and the minimum near the summer, the amount of the variation ranging from 1″ to nearly 2″.

CORRECTIONS, BY GROUPS, TO THE EPHEMERIS DECLINATION OF THE SUN

Clamp West 1903-4		Clamp East 1904-5		Clamp West 1905-6		Clamp East 1907-8		Clamp West 1908-9		Clamp East 1909-11		
Sept. 13	0.″33	Sept. 15	0.″70	Aug. 26	—0.″60	May 2	0.″33	May 14	—0.″51	May 22	—0.″43	0.″12
Oct. 1	0.36	30	0.30	Sept. 17	—0.33	20	0.58	June 4	—0.54	June 18	—0.32	0.38
23	0.10	Oct. 17	0.07	30	—0.40	June 16	—0.29	24	—0.68	July 2	0.02	25	—0.36
Nov. 9	0.62	Nov. 2	0.75	Oct. 19	—0.13	July 7	—0.08	July 13	—0.58	20	—0.14	July 14	—0.02
Dec. 2	0.61	25	0.55	Nov. 11	0.40	30	0.01	Aug. 6	—0.57	Aug. 6	—0.07	31	0.82
19	0.44	Dec. 24	1.00	Dec. 3	0.38	Aug. 22	—0.01	27	—0.61	24	—0.09	Aug. 14	0.48
Jan. 16	0.57	Jan. 22	1.00	27	0.63	Sept. 13	0.36	Sept. 14	—0.04	Sept. 9	—0.04	Sept. 3	0.36
Feb. 15	0.41	Feb. 15	0.95	Jan. 26	0.78	Oct. 4	0.54	Oct. 7	0.16	28	0.00	19	0.31
Mar 14	—0.06	Mar. 11	0.41	Feb. 20	0.54	19	0.33	26	—0.23	Oct. 11	—0.48	Oct. 4	0.81
Apr. 12	—0.69	Apr. 1	0.10	Mar. 21	0.08	Nov. 5	0.72	Nov. 12	0.03	25	0.05	20	0.38
May 2	—0.22	22	0.33	Apr. 23	—0.06	26	0.82	Dec. 2	—0.09	Nov. 8	—0.07	Nov. 8	0.35
23	—0.45	May 9	0.09	June 19	—0.18	Dec. 29	0.89	31	0.36	29	0.60	26	0.58
June 13	0.02	July 3	0.52	July 3	—0.38	Jan. 28	0.84	Jan. 27	0.26	Dec. 17	0.56	Dec. 16	1.00
30	—0.21	June 12	0.17	Sept. 3	—0.63	Mar. 2	0.54	Feb. 19	0.06	Jan. 5	1.05	Jan. 9	1.14
July 19	0.31			Oct. 5	—0.92	Apr. 15	—0.34	Apr. 2	—0.16	Feb. 10	0.50	30	0.82
Aug. 7	—0.04							21	—0.33	Mar. 11	0.74	Feb. 22	1.04
										27	0.66	Mar. 16	0.63
										Apr. 13	0.16	30	0.50
										30	0.37		

Such an annual variation in the correction from observation to the ephemeris declination of the Sun will arise if the observations are reduced with the wrong refraction or if the ephemeris is not computed with the true obliquity of the ecliptic, and the observations can be almost equally well satisfied by either assumption.

A preliminary discussion of these observations, together with a series of observations of the Moon covering the same period, taken in connection with the results from the comparison of the zodiacal star observations with those made at the Cape of Good Hope, and the results obtained from the stars observed both by day and by night, indicated that a refraction differing from that obtained from the circumpolar observations was highly improbable.

Having thus eliminated an error in the refraction as a possible explanation of the annual variation in the observed correction to the ephemeris declinations of the sun, the following corrections to the obliquity of the ecliptic were obtained from those observations:

$$\overset{1903\text{-}6}{\Delta\epsilon = -0''.415 \pm 0''.044} \qquad \overset{1907\text{-}11}{\Delta\epsilon = -0''.410 \pm 0''.034}$$

The discussion of the observed declinations of the Moon gave a correction to the ephemeris value of the obliquity of the ecliptic of about $-0''.5$.

Newcomb's mean obliquity of the ecliptic (the ephemeris value) for 1907 is $23^\circ\ 27'\ 4''.98$. Applying a correction of $-0''.41$, the seconds become $4''.57$. Peters value is $4''.51$ and that of LeVerrier is $4''.70$.

The full details of the above discussion will be found in Volume IX, Part I, *Publications of the U. S. Naval Observatory, Second Series.*

THE REFRACTION AT WASHINGTON.

By W. S. Eichelberger.

From September 1903 to May 1910 there were made with the 9-inch transit circle of the U. S. Naval Observatory 4250 observations of 138 stars that can be observed there at both the upper and lower culminations, 2150 at upper culmination and 2100 at lower. The observations extend from $24^\circ.3$ north zenith distance to $77^\circ.9$. The observations were reduced with the Pulkowa Refraction Tables and a latitude for the transit circle of $+38^\circ\ 55'\ 14''.1$ A discussion of the observations gave a correction of $+0''.264 \pm 0''.038$ to the latitude and $-(0''.134 \pm 0''.026) \tan z$ to the refraction. The mean differences

between the declinations at lower and upper culmination are shown in the following table:

Declination	No. Stars	Decl.L—Decl.U (Pulk. Ref.)	Res.
89° to 78°	44	+0".19	+0".01
78 to 71	47	+0.09	−0.03
71 to 63	47	+0.04	+0.04

During the same period the positions of about 2700 zodiacal stars were determined, and these were compared with the positions of the same stars obtained at the Cape of Good Hope Observatory. The difference in epoch is about three years. The discussion of the results of the comparison of the Cape and Washington observations gave a correction to the refraction at Washington of $-(0''.201 \pm 0''.075)\tan z$ and at the Cape of $-(0''.106 \pm 0''.089)\tan z$. The Cape observations were reduced with the Pulkowa Refraction Tables, as were those at Washington.

The differences between the declinations reduced with the Pulkowa refractions and the residuals from the above discussion follow:

Mean Decl.	Decl.C—Decl.W (Pulk. Ref.)	Res.
+26°.7	−0".36	−0".04
21.0	−0.28	+0.06
15.0	−0.40	−0.06
9.0	−0.35	−0.01
+ 3.0	−0.44	−0.11
− 3.0	−0.28	+0.03
9.0	−0.26	+0.02
15.0	−0.21	+0.03
21.0	−0.18	0.00
−26.8	−0.14	−0.05

If these two determinations of the correction necessary at Washington to the Pulkowa refractions be combined according to their probable errors we have

$$\text{Corr. to Pulk. Ref.} = -0''.14 \tan z$$

When the differences (Decl.C − Decl.W) were arranged according to the right ascension and grouped, the residuals showed a decided variation with right ascension. A thorough discussion of the available data, however, including the circumpolar observations and about 2000 observations of southern stars showed no evidence of a variable refraction throughout the nights or throughout the year.

The corrections to the results reduced with the Pulkowa refractions according to the above discussions are for observations between the pole and the southern horizon as follows:

Decl.	Corr.	Decl.	Corr.
°	″	°	″
90	+0.10	20	+0.31
80	+0.15	+10	+0.34
70	+0.18	0	+0.37
60	+0.21	−10	+0.42
50	+0.24	−20	+0.49
40	+0.26	−30	+0.61
30	+0.28		

The full details of the above discussions will be found in Volume IX, Part I, *Publications of the U. S. Naval Observatory, Second Series.*

DAY OBSERVATIONS MINUS NIGHT OBSERVATIONS.

By W. S. Eichelberger and F. B. Littell.

In July 1909 there was selected for observation with the 9-inch transit circle of the U. S. Naval Observatory, two groups of six clock stars each, the mean right ascensions of the two groups being approximately 6^h and 18^h respectively. Both of these groups were observed whenever possible from that date until April 1911, about 21 months. The mean clock correction for each group was formed for each set of observations using the right ascensions of Newcomb's Fundamental Catalogue.

Whenever the same observer observed both groups at successive transits, i. e., at an interval of twelve hours, the clock correction from one of the groups was reduced by the adopted clock rate to the time of the other group, and the difference between the results from the two groups was formed.

Let N_6 represent a night clock correction from the 6-hour group.
D_6 " " day " " " " " "
N_{18} " " night " " " " 18-hour "
D_{18} " " day " " " " " "

x represent the correction to reduce a day clock correction to a night clock correction; different for each observer.

y represent the correction to reduce a clock correction from the 18-hour group to one from the 6-hour group, due to error of assumed positions of clock stars.

Then

$$N_6 = D_{18} + x + y \qquad x + y = N_6 - D_{18}$$

or

$$N_{18} + y = D_6 + x \qquad x - y = N_{18} - D_6$$

By means of these equations and the clock corrections determined as above there were obtained

$$p = +\ 0^s.034 \qquad x_m = -\ 0^s.040$$
$$x_1 = -\ 0\ .022 \qquad x_p = -\ 0\ .024$$

i. e., a clock correction determined by day is too large for each of the three observers, as compared with one determined by night, and a clock correction determined from the stars of the 18-hour group is too small by $0^s.034$ as compared with one determined from the stars of the 6-hour group.

To exhibit this daylight effect in a somewhat different form, the final right ascensions of the individual observations of these twelve stars, determined by the use of night clock corrections only, were considered. The observations of each star made during a continuous period of from eight to nine months were divided into five groups, those observed in the morning after sunrise, those observed during morning twilight, those observed at night, those observed during the evening twilight, and those observed before sunset. Some of these groups were further subdivided so as to make the number of observations in each sub-group approximately the same. In each series for each star the mean of all the night observations were made and subtracted from the group means of that series. The results for each star will be published in Part I Volume IX of the Observatory Publications, and the mean results for each series are given here.

R. A. − R. A.$_N$

	First Series	Second Series	Third Series	Mean	No. Obs.	
	s	s	s	s		
Group I	+0.015	−0.002	−0.008	−0.003	38	More than 45^m after sunrise
	+0.008	−0.009	−0.046	−0.023	108	Less than 45^m after sunrise
Group II	−0.004	−0.002	−0.004	−0.003	216	
		0.000				
	+0.004		+0.004			
	0.000	−0.002	0.000			
	−0.005	+0.001	0.000			
Group III	−0.001	+0.005	−0.012			
	+0.001		+0.004			
	0.000	−0.003	−0.001			
		−0.008				
Group IV	−0.006	−0.009	−0.003	−0.007	213	
Group V	−0.034	−0.015	−0.034	−0.027	141	Less than 45^m before sunset
	−0.069	−0.048	−0.075	−0.058	97	More than 45^m before sunset

The mean time of the first sub-group is about $1^h\ 15^m$ after sunrise, and of the last sub-group about $1^h\ 15^m$ before sunset.

The above figures indicate that the same mean right ascension of a star results from all night observations independent of the time of transit,

that a slightly smaller value, smaller by less than $0^s.01$, however, results from twilight observations, and that a decidedly smaller value, varying somewhat with the time of transit results from daylight observations.

The two methods of treatment give entirely accordant results.

Treating the declinations of these twelve stars in the manner described above, we obtain:

Decl. − Decl.$_N$

	First Series	Second Series	Third Series	Mean	No. Obs.	
Group I	+0".81	−0".44	−0".46	−0".35	39	More than 45^m after sunrise
	−0.05	−0.24	−0.46	−0.30	115	Less than 45^m after sunrise
Group II	−0.07	−0.01 +0.03	−0.06	−0.03	229	
Group III	+0.10 −0.06 +0.07 0.00 +0.04 −0.31	+0.04 −0.01 +0.03 −0.06	−0.06 −0.08 +0.08 −0.15 +0.12 +0.03			
Group IV	−0.12	−0.15 −0.20	+0.12	−0.09	218	
Group V	−0.51	−0.41	−0.35	−0.42	152	Less than 45^m before sunset
	−0.83	−0.81	−1.01	−0.82	114	More than 45^m before sunset

The above figures indicate that the zenith distances of a south star resulting from night observations are practically the same whatever the time of transit, that those resulting from twilight observations are slightly greater, but greater by less than 0".1, and that those resulting from daylight observations are decidedly greater, the amount varying somewhat with the time of transit.

COMPARISON OF WASHINGTON RIGHT ASCENSIONS WITH THOSE OF NEWCOMB, AUWERS, BOSS, HEDRICK, AND PULKOWA 1905.

By W. S. Eichelberger and H. R. Morgan.

The 45,000 star observations made with the 9-inch transit circle of the U. S. Naval Observatory from 1903 to 1911 have been reduced and the results are now ready for publication. They will appear in Volume IX, *Publications of the U. S. Naval Observatory, Second Series.*

The effect of star magnitude upon the final right ascensions has been eliminated, largely through the use of wire gauze screens, and finally by applying for each observer, his personal equation in magnitude, for the difference between the screened magnitude and magnitude 8.0.

The effect of the periodic error in the right ascensions of Newcomb's catalogue, from which the positions of the clock stars were originally

taken, has been eliminated by successive determinations of the right ascensions of those clock stars from the observations themselves.

The effect of an error in the adopted equinox of the clock stars has been eliminated by determining the correction to the equinox from a discussion of the Sun observations 1903 to 1911, account having been taken in the discussion, of the difference in personal equation in observing a transit of the Sun and that of a star.

The effect of the varying personal equation of the observers with declination, with change in the direction of motion of stars north of the zenith from that of stars to the south, and with changing from observing with a chronograph to observing eye and ear, has been eliminated by determining the absolute value of these various personal equations with the personal equation machine.

The comparisons of the results with the five catalogues named are given in the following tables:

THE CORRECTIONS TO THE RIGHT ASCENSIONS VARYING WITH THE DECLINATION.

Declination	W.—N.	W.—A.	W.—B.	W.—H.	W.—P.
	s	s	s	s	s
+65° to +70° S. P.	−0.049	−0.009	−0.018		−0.012
+70 to +75 S. P.	− .033	+ .007	− .014		+ .011
+75 to +80 S. P.	− .053	− .004	− .035		+ .027
+80 to +85 S. P.	− .140	− .040	− .106		+ .019
+85 to +90 S. P.	+ .261	+ .144	+ .132		+ .274
+90 to +85	+ .161	+ .040	− .047		+ .171
+85 to +80	− .136	− .005	− .137		+ .056
+80 to +75	− .077	− .027	− .064		− .006
+75 to +70	− .079	− .039	− .059		− .023
+70 to +65	− .070	− .030	− .041		− .036
+65 to +60	− .081	− .055	− .064		− .051
+60 to +55	− .102	− .056	− .061		− .037
+55 to +50	− .095	− .049	− .049		− .041
+50 to +45	− .087	− .047	− .044		− .043
+45 to +40	− .065	− .057	− .037		− .037
+40 to +35	− .052	− .038	− .033		− .032
+35 to +30	− .046	− .042	− .037		− .033
+30 to +25	− .050	− .035	− .032	−0.066	− .032
+25 to +20	− .038	− .035	− .029	− .063	− .033
+20 to +15	− .042	− .033	− .030	− .048	− .031
+15 to +10	− .035	− .025	− .025	− .056	− .030
+10 to + 5	− .030	− .021	− .022	− .060	− .024
+ 5 to 0	− .024	− .023	− .017	− .051	− .022
0 to − 5	− .031	− .022	− .017	− .048	− .022
− 5 to −10	− .026	− .015	− .013	− .040	−0.023
−10 to −15	− .013	− .007	− .009	− .032	
−15 to −20	− .005	− .008	− .010	− .031	
−20 to −25	+ .013	+ .002	− .006	− .044	
−25 to −30	+ .029	+ .025	− .007	−0.066	
−30 to −35	+0.036	+0.021	−0.010		
+30 to −20	−0.029	−0.022	−0.020	−0.050	−0.025*

* This mean includes the corrections between the declinations +20° and −10°.

The corrections on the last line of the preceding table may be considered as the correction to the equinox of the various catalogues at 1907 as given by the Washington observations. If a correction for equinox of $-0^s.025$ be applied to the positions of the Pulkowa Catalogue*, the last column of the above table shows that the meridians of the Washington and Pulkowa catalogues cross at about $+10°$ and $+70°$ declination and that their distance apart between these two points would always be less than $0''.2$. The large difference between the correction to Hedrick's catalogue and the corrections to the other catalogues, which are fairly accordant among themselves, is due to star magnitude.

To obtain the relative magnitude equations for the various catalogues of comparison respectively referred to the Washington Catalogue, the mean difference for each five degree group was subtracted from the individual star differences in that group and the residuals arranged according to magnitude. This was done for the ten groups $+30°$ to $-20°$ (Pulkowa, six groups $+20°$ to $-10°$), and all the residuals for each catalogue of comparison were then grouped according to magnitude with the following result:

THE CORRECTION TO THE RIGHT ASCENSIONS VARYING WITH THE STAR MAGNITUDE.

Mean	W.—N.	+0.029	W.—A.	+0.022	W.—B.	+0.020	W.—H	+0.050	W.—P.	+0.025
Mag.	Obs.	O.—C.	Obs.	O.—C.	Obs.	O.—C.	Obs.	O.—C.	Obs.	O.—C.
	s	s	s	s	s	s	s		s	s
0.9	+0.026	+0.003	+0.019	—0.003	—0.005	—0.002			+0.009	0.000
1.8	+ .016	— .001	+ .015	.000	— .001	+ .001			+ .004	— .002
2.3	+ .019	+ .005	+ .015	+ .004	+ .004	+ .006			+ .010	+ .005
2.8	+ .015	+ .004	+ .010	+ .002	+ .003	+ .004			+ .002	— .001
3.3	+ .008	.000	+ .003	— .001	— .001	.000			+ .003	+ .001
3.8	+ .001	— .003	.000	— .001	— .002	— .002	+0 018	+0.003	— .001	— .001
4.3	+ .004	+ .003	— .003	.000	+ .001	+ .001	+ .017	+ .005	+ .002	+ .003
4.8	— .006	— .004	— .006	+ .001	— .002	— .002	— .001	— .010	— .008	— .005
5.3	— .005	.000	— .012	— .002	+ .001	.000	+ .004	— .002	— .005	— .001
5.8	— .004	+ .004	— .012	+ .002	— .002	— .003	— .003	— .006	— .003	+ .003
6.3	—0.010	+0.002	—0.014	+0.003	+0.009	+0.008	+ .010	+ .010	+0.002	+0.010
6.8							— .006	— .003		
7.3							— .008	— .002		
7.8							— .009	— .001		
8.4							—0.060	—0.048		

Determining the magnitude equation for each catalogue by a least squares solution, each star residual being given equal weight, the following expressions were obtained:

* No correction for equinox was determined in the formation of this catalogue.

W.—N. = —0ˢ.029 — (0ˢ.0064 ± 0.0006) (M — 4.5)
W.—A. = —0 .023 — (0 .0072 ± 0.0003) (M — 4.0)
W.—B. = —0 .020 + (0 .0007 ± 0.0006) (M — 4.5)
W.—H. = —0 .051 — (0 .0059 ± 0.0021) (M — 6.5)
W.—P. = —0 .025 — (0 .0030 ± 0.0005) (M — 4,0)

These results show that as far as the Washington observations furnish evidence, the magnitude equation has been almost, if not entirely, eliminated from Boss's Preliminary General Catalogue, and that by the use of the self-registering micrometer, the magnitude equation of the Pulkowa Catalogue has been reduced to forty or fifty per cent of that in the uncorrected standard catalogues.

To obtain the variation with right ascension of the right ascension correction of the various catalogues of comparison referred to the Washington Catalogue, the residuals used in determining the magnitude equations were rearranged according to right ascension and means were taken by three hour groups, with the following results:

THE CORRECTIONS TO THE RIGHT ASCENSIONS VARYING WITH THE RIGHT ASCENSION.

	Newcomb		Auwers		Boss		Pulkowa		Hedrick	
R.A.	Obs.	O.—C.	Obs.	O.—C.	Obs.	O.—C.	Obs.	O.—C.	Obs.	O.—C.
h h	s	s	s	s	s	s	s	s	s	s
0— 3	+0.009	+0.003	+0.014	+0.004	+0.010	+0.002	—0.005	—0.001	+0.011	+0.002
3— 6	— .007	.000	— .002	.000	— .004	.000	.000	+ .001	— .015	— .004
6— 9	— .014	— .004	— .014	— .004	— .011	— .002	+ .002	— .001	— .010	+ .005
9—12	+ .003	+ .007	— .004	+ .005	— .003	+ .003	— .005	.000	— .013	— .004
12—15	— .007	— .007	— .009	— .003	— .008	— .003	— .010	.000	— .006	+ .002
15—18	+ .002	+ .004	— .005	— .001	— .002	+ .001	— .001	.000	— .003	.000
18—21	+ .004	+ .001	+ .006	+ .004	+ .008	+ .001	+ .009	.000	+ .014	.000
21—24	+ .007	— .003	+ .007	— .005	+ .012	— .002	+ .004	.000	+ .023	— .001

Determining by a least squares solution the periodic expression to best represent each of the above sets of residuals, we have:

W.—N. =	—0ˢ.029	—0ˢ.005 sin α	+0ˢ.005 cos α	+0ˢ.000 sin 2α	+0ˢ.005 cos 2α —0ˢ.0064 (M — 4.5)
W.—A. =	—0 .024	—0 .003	+0 .010	+0 .001	+0 .004 —0 .0072 (M — 4.0)
W.—B. =	—0 .020	—0 .005	+0 .009	—0 .002	+0 .004 +0 .0007 (M — 4.5)
W.—P. =	—0 .026	—0 .002	+0 .004	—0 .005	—0 .005 —0 .0030 (M — 4.0)
W.—H. =	—0 .051	—0 .010	+0 .013	—0 .005	+0 .005 —0 .0059 (M — 6.5)

The perfect representation of the differences W.—P. by the above expression indicates that any error varying with the right ascension in either catalogue is purely periodic, while the O.—C. columns for the standard catalogues indicate that the same is not true in their cases.

COMPARISON OF WASHINGTON DECLINATIONS WITH THOSE OF NEWCOMB, AUWERS, AND BOSS.

By W. S. Eichelberger and H. R. Morgan.

The 45,000 star observations made with the 9-inch transit circle of the U. S. Naval Observatory from 1903 to 1911 have been reduced and the results are now ready for publication. They will appear in Vol. IX, *Publications of the U.S. Naval Observatory, Second Series.*

The division errors were determined for each 2′ line of the circle with probable error of 0″.04 and applied to all the observed declinations.

The flexure of the instrument was determined by the use of horizontal and vertical collimators. Reduced with these determinations the direct and reflected observations and the results, clamp west and clamp east, show a satisfactory agreement.

The variation of latitude determined by the International Geodetic Association has been used in all the reductions.

The bisection equation of each observer was determined and the necessary correction applied in each case.

The corrections to the assumed latitude and refraction were obtained from a discussion of the circumpolar observations and used in the final reductions.

The comparisons of the results with the three catalogues named are given in the following tables:

The Corrections to the Declinations Varying with the Declination.

Declination	W.—N.	W.—A.	W.—B.
+63° to +70° S. P.	+0″.20	+0″.11	+0″.15
+70 to +80 S. P.	+ .14	+ .07	+ .10
+80 to +90 S. P.	— .08	.00	— .08
+90 to +80	— .05	— .05	.00
+80 to +70	+ .17	+ .10	+ .14
+70 to +60	+ .18	+ .13	+ .16
+60 to +50	+ .05	+ .28	+ .34
+50 to +40	+ .33	+ .52	+ .61
+40 to +30	+ .31	+ .35	+ .64
+30 to +20	+ .49	+ .55	+ .74
+20 to +10	+ .67	+ .72	+ .92
+10 to 0	+ .52	+ .79	+ .85
0 to −10	+ .50	+ .72	+ .84
−10 to −20	+ .44	+ .61	+ .76
−20 to −35	+ .71	+ .78	+ .81

Within 30° of the pole, the corrections to the declinations of each of the three general catalogues as given by the Washington observations

are practically the same, varying from zero at the pole to about +0″.2 at 60° north declination. For stars south of 30° north declination, the corrections vary hardly more than 0″.1 from +0″.5 for Newcomb +0″.7 for Auwers, and +0″.8 for Boss.

The large change in the value of the observed corrections to these catalogues in passing from 30° to 60° north declination cannot be attributed to a discontinuity in the Washington observations at the zenith, as this subject was thoroughly investigated and such a discontinuity guarded against; also the corrections contiguous to the Washington zenith indicate the non-existence of such a discontinuity. Further the constancy of the corrections from 20° zenith distance at Washington to the horizon both north of the zenith and south of it eliminates the possibility of attributing the large change in the corrections near the zenith to errors in the adopted flexure or refraction. The only plausible explanation that has suggested itself is that there exist in various observational catalogues used in the formation of these general catalogues discontinuities at their several zeniths, most of which lie between 30° and 60° north of the equator. That such discontinuities exist in at least two catalogues is shown by the writer in *Publications of the Astronomical and Astrophysical Society of America*, Volume II, page 170.

In the following table, giving the variations of the declination correction with right ascension, the column headed S contains the results for stars from +30° to −20° declination, the column headed N, the results for stars from +90° to +50° declination.

THE CORRECTIONS TO THE DECLINATIONS VARYING WITH THE RIGHT ASCENSIONS.

Right Ascension	W.—N.		W.—A.		W.—B.	
	S	N	S	N	S	N
h h						
0 to 3	+0″.52	+0″.09	+0″.68	+0″.22	+0″.80	+0″.21
3 to 6	+ .60	+ .09	+ .73	+ .13	+ .79	+ .17
6 to 9	+ .46	+ .01	+ .58	+ .08	+ .71	+ .04
9 to 12	+ .41	+ .14	+ .54	+ .06	+ .82	+ .18
12 to 15	+ .49	+ .15	+ .70	+ .07	+ .81	+ .17
15 to 18	+ .57	+ .15	+ .72	+ .15	+ .91	+ .24
18 to 21	+ .56	+ .14	+ .69	+ .23	+ .91	+ .28
21 to 24	+ .60	+ .12	+ .72	+ .31	+ .85	+ .21

These results indicate that the declinations of the fundamental catalogues are relatively too far north at about nine hours right ascension. The declinations from the altazimuth observations, *Publications of the U. S. Naval Observatory, Second Series*, Volume VIII, and those obtained with the Greenwich Transit Circle, *Monthly Notices R. A. S.*, January 1916, page 216, give the same indication.

RADIAL VELOCITIES WITH THE OBJECTIVE PRISM.

By T. S. H. Graham. (Introduced by C. A. Chant.)

In *Harvard Circular* No. 154 is suggested a method for determining radial velocities of stars from spectra obtained with the objective prism, by using the absorption band λ 4272 produced by a ray-filter of neodymium chloride. Director Pickering courteously supplied a plate taken by means of the 16-inch Metcalf telescope, and measurements on it were made at the University of Toronto with an instrument similar to those devised and constructed at the Harvard College Observatory. The attached microscope had a filar micrometer eyepiece, and the magnification was about 40. This was rather high but it was the lowest available at the time. The reductions were made with Hartmann's formula and the spectrum lines generally used were Hγ, Hδ, Hϵ, though sometimes Fe 4325.94, Fe 4308.08 and Ca 4226.90.

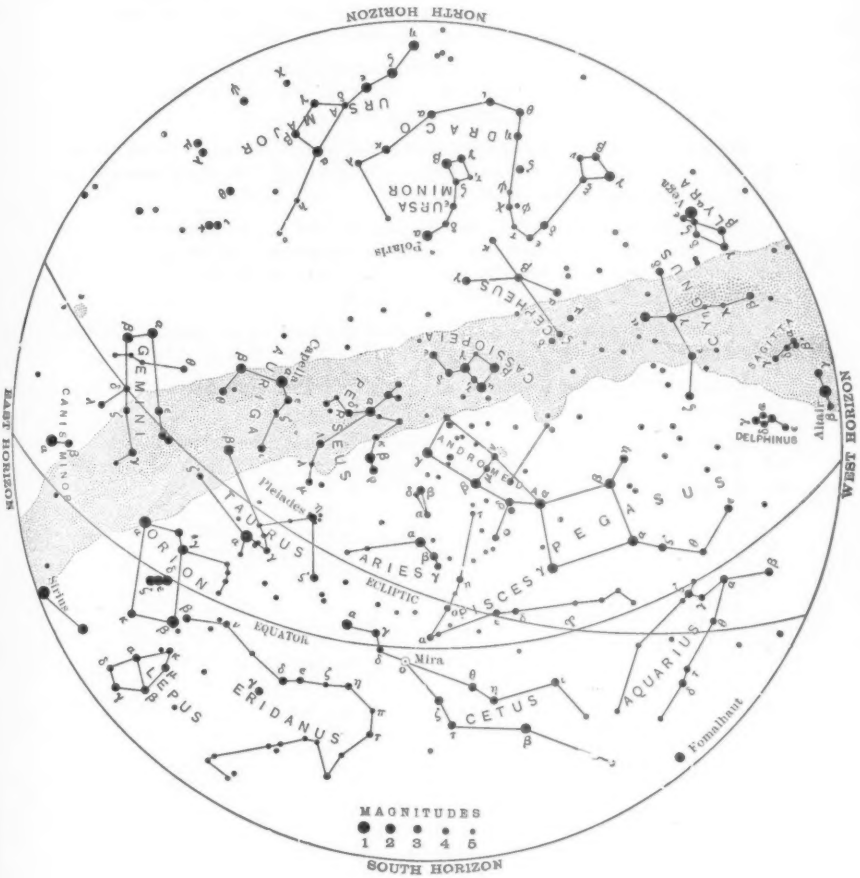
The spectra of twenty stars were measured, four sets being made on each star, and the reduction of each set was entirely independent of the others. The plate was MC 8262, with centre at α 12^h 36^m, δ $+40^\circ$ $30'$ (*Canes Venatici*). The following table gives the velocities obtained for five stars and shows the nature of the results. They vary considerably, but the work seems to indicate the value of the method for the fainter stars. The velocities are reduced to the Sun.

Designation	Type	Set	Hγ 4340.66	Fe	Hδ 4101.90	Hϵ 3970.18	Mean Vel.
			km	km	km	km	km
4	[F]	1	+84.0		+69.8	+66.3	+73.3
		2	+79.3		+65.2	+63.7	+69.4
		3	+79.3		+65.2	+63.5	+69.3
		4	+74.9		+62.2	+60.1	+65.7
9	A	1	+ 4.4		+ 7.6	+ 3.5	+ 5.2
		2	+21.9		+15.6	+18.2	+18.4
		3	+26.2		+19.5	+21.7	+22.5
		4	+ 8.6		+ 4.2	+ 7.7	+ 6.8
10	F	1	+97.2	+47.3	+80.2	+76.8	+75.4
		2	+88.2		+74.0	+70.5	+77.7
		3	+70.5		+57.6	+56.5	+61.5
		4	+70.5		+57.7	+56.5	+61.6
13	[A]	1	−30.9		−20.8		−25.8
		2	−26.7		− 7.2		−17.0
		3	−26.7		−16.6		−21.6
		4	−13.5		−14.9		−14.2
β	G	1	+ 4.4	− 4.3			0
		2	+ 8.6	+12.9			+10.7
		3	+26.3	+12.9			+19.6
		4	− 0.2	+17.2			+ 8.5

(To be continued.)

PLANET NOTES FOR DECEMBER, 1917.

The sun will continue to move southward until December 22 when it reaches its greatest declination south for the year. This is the date of the winter solstice. After this date the sun will again move northeastward.



THE CONSTELLATIONS AT 9:00 P. M. DECMBER 1.

The phases of the moon for this month are as follows:

Last Quarter	Dec.	6	at 8 A.M.	C.S.T.
New Moon		14	" 3 A.M.	"
First Quarter		20	" 12 P.M.	"
Full Moon		27	" 4 A.M.	"

Mercury will move eastward ahead of the sun until December 24. On this date it will change its motion from eastward to westward. On December 16 it will be in a position of greatest elongation east. It will then set a little more than an hour after the sun, and may be seen near the horizon at sunset.

Venus will have continuous movement eastward during the month. At the beginning of the month it will still be near the point of greatest elongation east, and will therefore be conspicuous in the evening sky.

Mars will rise on the average throughout the month about six hours before the sun. If observed at all it will have to be observed in the early morning. It will be coming nearer to the earth.

Jupiter will just have passed its point of opposition at the beginning of the month. It will rise earlier each evening and by the end of the month will reach the meridian shortly after nine in the evening. Jupiter, therefore, will be in excellent position for observation during the month.

Saturn will rise late at night, and like Mars will have to be observed in the early morning. It will rise a few hours earlier than Mars.

Uranus will be a few hours east of the sun during the month, and may be observed in the western sky after sunset.

Neptune will be in the same part of the sky as Saturn during the month. It will therefore be in a position to be observed about midnight and later throughout the month.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1917	Star's Name	Magnitude	IMMERSION. Washington M.T.		Angle f'm N.	EMERSION. Washington M.T.		Angle f'm N.	Duration	
			h	m	°	h	m	°	h	m
Dec. 1	*g* Geminorum	5.0	18	13	135	19	18	274	1	05
3	222 B Cancri	6.3	13	32	120	14	57	294	1	25
5	237 B Leonis	5.3	18	24	162	19	36	271	1	11
6	*e* Leonis	5.1	14	07	182	14	39	237	0	32
22	101 Piscium	6.2	13	18	103	14	07	228	0	49
24	ζ Arietis	5.0	5	18	87	6	25	230	1	07
27	3 Geminorum	5.6	5	34	69	6	30	286	0	56
27	6 Geminorum	6.3	6	45	120	7	42	237	0	57
27	μ Geminorum	3.2	13	39	178	14	03	212	0	24

Phenomena of Jupiter's Satellites,

VISIBLE AT WASHINGTON.

[*From the American Ephemeris.*]

CENTRAL STANDARD TIME.

1917	h	m		
Dec. 1	5	04	III	Ec. R.
	5	13	II	Oc. D.
	6	39	I	Tr. I.
	6	43	I	Sh. I.
	7	50	II	Ec. R.
	8	48	I	Tr. E.
	8	53	I	Sh. E.
2	6	07	I	Ec. R.
4	16	38	III	Tr. I.
	17	10	III	Sh. I.
5	16	42	I	Oc. D.
6	12	48	II	Tr. I.
	13	13	II	Sh. I.
	13	56	I	Tr. I.
	14	09	II	Sh. I.
	15	17	II	Tr. E.
	15	45	II	Sh. E.
	16	06	I	Tr. E.
	16	19	I	Sh. E.
7	11	08	I	Oc. D.
	13	33	I	Ec. R.
8	6	05	III	Oc. D.
	7	26	II	Oc. D.
	8	22	I	Tr. I.
	8	37	I	Sh. I.
	9	05	III	Ec. R.
	10	25	II	Ec. R.
	10	32	I	Tr. E.
	10	48	I	Sh. E.
9	5	34	I	Oc. D.
	8	02	I	Ec. R.
10	4	25	II	Tr. E.
	4	58	I	Tr. E.
	5	04	II	Sh. E.
	5	16	I	Sh. E.
13	15	04	II	Tr. I.
	15	40	I	Tr. I.
	15	51	II	Sh. I.
	16	03	I	Sh. I.
14	12	52	I	Oc. D.
	15	29	I	Ec. R.
15	9	21	III	Oc. D.
	9	49	II	Oc. D.
	10	06	I	Tr. I.
	10	32	I	Sh. I.
	12	16	I	Tr. E.
	12	42	I	Sh. E.
	13	01	II	Ec. R.
	13	07	III	Ec. R.

1917	h	m		
Dec. 16	7	18	I	Oc. D.
	9	57	I	Ec. R.
17	4	32	I	Tr. I.
	5	00	I	Sh. I.
	5	11	II	Sh. I.
	6	42	I	Tr. E.
	6	42	II	Tr. E.
	7	11	I	Sh. E.
	7	42	II	Sh. E.
18	4	26	I	Ec. R.
21	14	37	I	Oc. D.
22	11	51	II	Oc. D.
	11	54	II	Oc. D.
	12	26	I	Sh. I.
	12	39	III	Oc. D.
	14	00	I	Tr. E.
	14	33	III	Oc. R.
	14	37	I	Sh. E.
	15	00	III	Ec. D.
	15	36	II	Ec. R.
23	9	03	I	Oc. D.
	11	53	I	Ec. R.
24	6	17	I	Tr. I.
	6	30	II	Tr. I.
	6	55	I	Sh. I.
	7	49	II	Sh. I.
	8	27	I	Tr. E.
	9	00	II	Tr. E.
	9	05	I	Sh. E.
	10	20	II	Sh. E.
25	6	22	I	Ec. R.
26	4	24	III	Tr. E.
	4	53	II	Ec. R.
	5	11	III	Sh. I.
	7	18	III	Sh. E.
29	13	37	I	Tr. I.
	14	11	II	Oc. D.
	14	21	I	Sh. I.
30	10	50	I	Oc. D.
	13	48	I	Ec. R.
31	8	03	I	Tr. I.
	8	50	I	Sh. I.
	8	50	II	Tr. I.
	10	13	I	Tr. E.
	10	27	II	Sh. I.
	11	00	I	Sh. E.
	11	20	II	Tr. E.
	12	59	II	Sh. E.

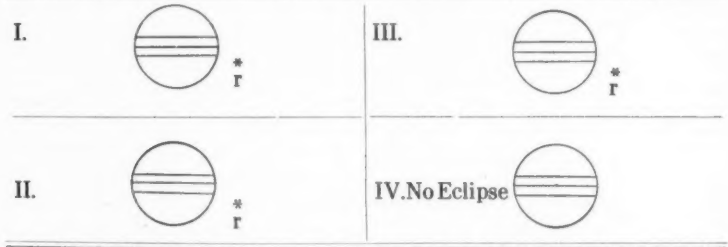
Note:—I., denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

Satellites of Jupiter, 1917.

GREENWICH MEAN TIME.

DECEMBER

Phases of the Eclipses of the Satellites for an Inverting Telescope.



Configurations at 16h 15m for an Inverting Telescope.

Day	West	East
1	4· 1· ○ ·2 ·3	
3	4· ○ ·1 2· ·3	
3	4· 2 1 · ○ 3·	
4	·4 ·2 ○ 3·1·	
5	·4 3· ·1 ○ ·2	
6	3· ·4 ○ 2·1·	
7	·2 3· ·4 ○ 1	
8	○ 1· ○ ·3 ·4	·2●
9	○ ·1 2· ·3 ·4	
10	2 1 · ○ 3· ·4	
11	·2 ○ 3 ·1	·4
12	3··1 ○ ·2	4·
13	3· ○ 2 · 1 ·	4·
14	·32· ·1 ○ 4·	
15	○ 1. ○ 4.	·2● ·3●
16	4· ○ ·1 2· ·3	
17	4· 2 1 · ○ 3·	
18	4· ·2 ○ ·1 3 ·	
19	4· 3 1 · ○ ·2	
20	·4 3· ○ 2 1 ·	
21	·4 ·3 2· ·1 ○	
22	·4 ·2 ·3 ○ 1·	
23	·4 ○ ·2 ·3	·1●
24	2 1 · ○ ·4 3·	
25	·2 ○ ·1 3· ·4	
26	1·3. ○ ·2	·4
27	3· ○ 1 · ·1	·4
28	·3 2· ·1 ○	·4
29	·2 ·3 ○ 1·	4·
30	·○1 ·2 ·3	4·
33	1· ○ 2· 4· .3	

VARIABLE STARS.

Minima of Variable Stars of Short Period.

[Calculated by Lois N. Wilson at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5h; Central Standard 6h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1917 December							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	3 13							
RT Sculptor.	31.5	−26 13	9.6—10.5	0 12.3	8 3;	15 19;	23 11;	31 3				
UU Androm.	38.5	+30 24	10.7—11.9	1 11.7	3 9;	10 19;	18 6;	25 16				
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	3 6;	10 18;	18 5;	25 17				
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	3 8;	9 11;	21 16;	27 19				
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	6 0;	13 4;	20 7;	27 11				
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	3 4;	10 0;	16 21;	30 15				
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	4 12;	11 16;	18 20;	26 0				
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	9 10;	18 5;	26 23					
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	7 8;	15 6;	23 5;	31 3				
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6		19 21						
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	1 17;	7 11;	18 22;	24 16				
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	3 0;	9 19;	23 10;	30 5				
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	7 1;	15 0;	22 21;	30 19				
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	7 12;	15 20;	24 3					
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	3 3;	11 0;	18 22;	26 19				
RW Persei	13.3	+42 04	8.8—11.0	15 04.8		12 14;		25 18				
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	7 7;	16 17;	26 4					
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1		11 10;	23 20					
TT Aurigae	5 02.8	+39 27	7.8— 8.7	0 16.0	1 18;	8 10;	21 18;	28 10				
RY Aurigae	11.5	+38 13	10.7—11.7	2 17.5	4 7;	12 12;	20 16;	28 21				
RZ Aurigae	42.9	+31 40	10.6—13.3	3 00.3	5 20;	11 21;	23 22;	29 22				
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	6 16;	15 8;	23 24					
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	1 3;	11 12;	21 22					
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2		8 15;	13 13;	24 14				
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	3 11;	9 5;	20 16;	26 10				
U Columbae	6 11.2	−33 03	9.2—10.0	2 19.2	1 15;	12 19;	24 0;	29 15				
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	8 0;	16 5;	24 10					
RW Monoc.	29.3	+ 8 54	9.0—10.8	1 21.7	6 1;	13 16;	21 7;	28 22				
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	8 11;		20 16					
RU Monoc.	6 49.4	− 7 28	9.8—10.5	0 21.5	2 16;	9 20;	17 0;	24 4				
R Can. Maj.	7 14.9	−16 12	5.8— 6.4	1 03.3	1 22;	8 17;	22 8;	29 4				
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	5 3;	14 10;	23 17					
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	5 19;	12 10;	19 1;	25 15				
TX Gemin.	30.3	+17 8	10.0—11.9	2 19.2	7 10;	15 20;	24 5					
RR Puppis	43.5	−41 08	9.4—10.7	6 10.3	4 18;	11 4;	24 1;	30 11				
V Puppis	7 55.4	−48 58	4.1— 4.8	1 10.9	3 8;	10 15;	17 22;	25 4				
X Carinae	8 29.1	−58 53	7.9— 8.7	0 13.0	2 16;	10 19;	18 22;	27 0				
S Cancri	8 38.2	+19 24	8.2—10	9 11.6		9 17;	19 4;	28 16				
RX Hydrae	9 00.8	− 7 52	9.1—10.5	2 6.8	2 0;	8 20;	22 13;	29 9				
S Velorum	29.4	−44 46	7.8— 9.3	5 22.4	2 21;	8 20;	20 17;	26 15				
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	5 13;	12 7;	19 1;	25 19				
RR Velorum	10 17.8	−41 36	10.0—10.9	1 20.5	4 8;	11 18;	19 4;	26 14				
SS Carinae	10 54.2	−61 23	12.2—12.8	3 07.2	4 10;	11 0;	24 5;	30 19				
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	1 5;	10 0;	18 19;	27 14				
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	3 23;	11 6;	18 14;	25 22				
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	2 0;	8 19;	22 8;	29 3				
RZ Centauri	12 55.6	−64 05	8.5— 8.9	1 21.0	4 2;	11 14;	19 2;	26 14				
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.2		10 13;	20 4;	29 18				
SS Centauri	13 07.2	−63 37	8.8—10.4	2 11.5	5 12;	12 22;	20 9;	27 19				
δ Librae	14 55.6	− 8 07	4.8— 6.2	2 07.9	4 15;	11 15;	18 14;	25 14				

Minima of Variable Stars of Short Period—Continued.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1917 December
	h m	° ′		d h	d h d h d h d h d h
U Coronae	15 14.1	+32 01	7.6— 8.7	3 10.9	4 6; 11 4; 18 2; 25 0
TW Draconis	32.4	+64 14	7.3— 8.9	2 9.12	4 2; 12 12; 20 22; 29 8
SS Librae	15 43.4	−15 14	9.3—11.5	0 18.4	5 11; 13 3; 20 18; 28 10
SW Ophiuchi	16 11.1	− 6 44	9.2—10.0	2 10.7	5 10; 12 18; 20 2; 27 10
SX Ophiuchi	12.6	− 6 25	10.5—11.2	2 01.5	1 11; 9 17; 17 23; 26 5
R Arae	31.1	−56 48	6.8— 7.9	4 10.2	2 14; 11 11; 20 7; 29 4
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	5 1; 14 17; 25 19
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	7 3; 13 23; 20 18; 27 13
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	4 14; 12 23; 21 9; 29 18
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	4 13; 10 17; 23 1; 29 4
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	3 23; 14 4; 21 9; 28 14
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	8 6; 15 15; 23 0; 30 9
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	8 6; 16 10; 24 14
TX Scorpii	48.6	−34 13	7.5— 8.2	0 22.6	7 9; 14 22; 22 11; 30 0
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	3 5; 10 23; 18 17; 26 11
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	7 23; 15 22; 23 22; 31 22
WX Sagittae	53.6	−17 24	9.2—10.8	2 03.1	3 2; 11 14; 20 3; 28 15
WY Sagittae	17 54.9	−23 1	9.5—10.6	4 16.0	9 20; 19 4; 28 12
SX Draconis	18 03.0	+ 58 23	9.3—10.5	5 04.1	4 19; 15 3; 25 11
RS Sagittarii	11.0	−34 08	5.9— 6.3	2 10.0	1 19; 9 1; 23 13; 30 19
V Serpentis	11.1	−15 34	9.5—11.1	3 10.9	1 23; 8 20; 22 16; 29 13
RZ Scuti	21.1	− 9 15	7.4— 8.3	15 03.2	13 7; 28 11
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	3 5; 9 9; 23 17; 30 21
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	7 13; 14 16; 21 19; 28 22
SX Sagittarii	39.7	−30 36	8.7— 9.8	2 01.8	7 13; 15 20; 24 4
RR Draconis	40.8	+62 34	9.3—13	2 19.9	7 13; 16 1; 24 3
RS Scuti	43.7	−10 21	9.3—10.3	0 15.9	6 13; 13 4; 19 20; 26 11
β Lyrae	46.4	+33 15	3.4— 4.1	12 21.8	3 21; 16 18; 29 16
U Scuti	18 48.9	−12 44	9.1— 9.6	0 22.9	5 16; 13 7; 20 23; 28 14
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	3 4; 9 18; 17 7; 24 21
RV Lyrae	12.5	+32 15	11. —12.8	3 14.4	3 19; 11 23; 19 4; 26 9
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	1 11; 10 9; 19 8; 28 7
U Sagittae	14.4	+19 26	6.5— 9.0	3 09.1	2 18; 9 13; 23 1; 27 9
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	2 3; 9 12; 16 21; 24 5
TT Lyrae	24.3	+41 30	9.3—11.6	5 05.8	5 9; 10 15; 21 3; 26 9
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 9; 8 21; 21 22; 28 11
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	1 2; 13 3; 19 3; 31 3
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	6 17; 13 8; 20 0; 26 15
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	5 17; 14 20; 24 0
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	4 0; 12 10; 20 20; 29 7
RW Capric.	12.2	−17 59	8.8—10.6	3 09.4	7 9; 14 4; 20 22; 27 17
UW Cygni	19.6	+42 55	10.5—10.8	3 10.8	4 9; 11 7; 18 5; 25 2
V Vulpec.	32.3	+26 15	8.2—9.8	37 19.0	25 15
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	9 0; 18 15; 28 6
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	10 2; 19 7; 28 12
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	5 8; 12 19; 20 7; 27 19
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	2 13; 10 3; 17 18; 25 8
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	7 3; 17 5; 27 8
VV Cygni	21 02.3	+45 23	12.1—13.8	1 11.4	5 19; 13 4; 20 14; 27 23
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	5 1; 14 17; 24 10
RY Aquarii	14.8	−11 14	8.8—10.4	1 23.2	2 21; 10 17; 18 15; 26 12
RT Lacertae	21 57.4	+43 24	9.1—10.5	5 01.7	2 3; 12 6; 22 10
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3	3 7
RW Lacertae	22 40.6	+49 08	10.2—11.2	5 04.4	3 2; 8 7; 18 16; 29 1
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.3	7 13; 15 20; 24 3
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.4	4 16; 12 5; 19 18; 27 6
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	1 3; 9 9; 17 15; 25 21

Maxima of Variable Stars of Short Period.

[Calculated by Julia M. Hawkes at Goodsell Observatory.]

Given to the nearest hour in Greenwich mean time. To obtain Eastern standard time subtract 5^h; Central standard time 6^h; etc.

Star	R. A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1917. December							
	h m	° ′		d h	d	h	d	h	d	h	d	h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	5	20						
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 1.7	3	8;	11	12;	19	15;	27	19
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	2	1;	9	19;	17	13;	25	7
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2			13	12;			28	7
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	5	3;	13	1;	20	23;	28	22
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	8	5;	16	0;	23	19;	31	14
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	2	5;	9	12;	24	1;	31	8
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	6						22	
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	6	7;	14	21;	23	11		
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	7	2;	18	5;	29	8		
RX Aurigae	4 54.5	+39 49	7.2— 8.1	11 15.0	7	22;	19	13;	31	4		
SX Aurigae	5 04.6	+42 02	8.0— 8.7	1 12.8	4	14;	12	6;	19	22;	27	14
SY Aurigae	05.5	+42 41	8.4— 9.5	10 03.3			10	23;	21	2;	31	5
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	1	4;	8	21;	16	14;	24	7
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	1	15;	12	16;	23	18;	29	6
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	3	2;	10	15;	18	5;	25	18
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3			10	0				
RT Aurigae	23.0	+30 33	5.1— 6.0	3 17.5	2	3;	9	13;	24	12;	31	23
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	1	14;	8	19;	16	0;	30	10
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	7	6;	15	4;	23	2;	31	0
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	3	3;	13	6;	23	10		
RU Camelop.	7 10.9	+69 51	8.5— 9.8	12 06.5					21	2		
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	3	21;	11	20;	19	19;	27	17
V Carinae	8 26.7	−59 47	7.4— 8.1	6 16.7	4	21;	11	14;	24	23;	31	16
T Velorum	8 34.4	−47 01	7.6— 8.5	4 15.3	1	1;	10	7;	19	14;	28	21
V Velorum	9 19.2	−55 32	7.5— 8.2	4 08.9	6	6;	14	23;	23	18		
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	6	16;	13	11;	20	6;	27	0
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	3	2;	9	17;	22	22;	29	12
S Muscae	12 07.4	−69 36	6.4— 7.3	9 15.8	3	23;	13	15;	23	7		
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	8	19;	16	18;	24	18		
T Crucis	15.9	−61 44	6.8— 7.6	6 17.6	2	7;	9	0;	22	11;	29	5
R Crucis	18.1	−61 04	6.8— 7.9	5 19.8	5	17;	11	12;	23	4;	29	0
S Crucis	12 48.4	−57 53	6.5— 7.6	4 16.6	1	15;	11	0;	20	9;	29	18
W Virginis	13 20.9	− 2 52	8.7—10.4	17 06.5	5	8			22	14		
SS Hydrae	25.0	−23 08	7.4— 8.1	8 4.8	6	0;	14	5;	22	10;	30	15
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	5	11;	12	12;	19	12;	26	13
ST Virginis	14 22.5	− 0 27	10.3—11.4	0 09.9	4	6;	12	11;	20	16;	28	21
V Centauri	25.4	−56 27	6.4— 7.8	5 11.9	5	19;	11	7;	22	7;	27	19
RS Bootis	29.3	+32 11	8.6—10.0	0 09.1	7	23;	15	12;	23	1;	30	14
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	1	22;	9	8;	16	18;	24	4
R Triang. Austr.	15 10.8	−66 08	6.7— 7.4	3 09.3	6	19;	13	14;	20	8;	27	3
S Triang. Austr.	15 52.2	−63 29	6.4— 7.4	6 07.8	4	20;	11	3;	23	19;	30	2
S Normae	16 10.6	−57 39	6.6— 7.6	9 18.1			10	9;	20	3;	29	21
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6			7	22;	16	18;	25	15
RV Scorpii	16 51.8	−33 27	6.7— 7.4	6 01.5	4	3;	10	5;	22	7;	28	9
X Sagittarii	17 41.3	−27 48	4.4— 5.0	7 00.3	6	0;	13	0;	20	0;	27	1
Y Ophiuchi	47.3	− 6 07	6.1— 6.5	17 02.9	6	0;			23	3		
W Sagittarii	17 58.6	−29 35	4.3— 5.1	7 14.3	7	3;	14	18;	22	8;	29	22
Y Sagittarii	18 15.5	−18 54	5.4— 6.2	5 18.6	3	0;	14	14;	26	3;	31	21
U Sagittarii	26.0	−19 12	6.5— 7.3	6 17.9	2	3;	8	21;	22	9;	29	3
Y Scuti	32.6	− 8 27	8.7— 9.2	10 08.3			10	13;	20	21;	31	6
Y Lyrae	34.2	+43 52	11.3—12.3	0 12.1	6	9;	12	9;	24	11;	30	12
RZ Lyrae	39.9	+32 42	9.9—11.2	0 12.3	3	23;	10	3;	22	9;	28	12
RT Scuti	44.1	−10 30	9.1— 9.7	0 11.9	2	8;	8	7;	20	4;	26	3
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	3	5;	12	7;	21	9;	30	12

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1917. December							
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
U Aquilae	19 24.0	− 7 15	6.2— 6.9	7 00.6	7 2;	14 3;	21 3;	28 4				
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	5 2;	12 2;	19 2;	26 1				
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	2 20;	10 20;	18 19;	26 19				
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	8 0;	15 17;	23 10;	31 2				
η Aquilae	47.4	+ 0 45	3.7— 4.5	7 04.2	2 20;	10 0;	24 9;	31 13				
S Sagittae	51.5	+16 22	5.6— 6.4	8 09.2	1 1;	9 11;	17 20;	26 5				
X Vulpec.	19 53.3	+26 17	9.51—0.5	6 07.7	2 2;	8 10;	21 2;	27 9				
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3		15 13;		31 22				
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	4 17;	13 14;	22 11;	26 22				
WY Cygni	52.3	+30 03	9.6—10.4	0 13.5	2 19;	9 12;	22 23;	29 17				
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	7 11;	14 4;	20 21;	27 14				
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4		15 13		30 9				
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	2 22;	10 18;	18 15;	26 12				
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	4 6;	11 3;	18 1;	24 22				
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	2 12;	12 5;	21 23;	26 19				
Y Lacertae	22 05.2	+50 33	9.1— 9.6	4 07.8	6 4;	14 20;	23 11					
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	2 7;	13 0;	18 9;	29 3				
Z Lacertae	36.9	+56 18	8.2— 9.0	10 21.1	2 9;	13 6;	24 3					
RR Lacertae	37.5	+55 55	8.5— 9.2	6 10.1	3 10;	9 20;	22 16;	29 2				
V Lacertae	22 44.5	+55 48	8.5— 9.5	4 23.6	2 10;	12 9;	17 8;	27 7				
X Lacertae	45.0	+55 54	8.2— 8.6	5 10.7	6 0;	11 10;	22 8;	27 18				
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	5 6;	10 16;	21 14;	27 0				
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	1 1;	7 8;	13 15;	26 6				
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	5 5;	17 8;	29 12;	31 15				
V Cephei	23 51.7	+82 38	6.0—7.0	0 23.6	2 0;	12 0;	21 23;	31 23				

COMET AND ASTEROID NOTES.

Comet *c* 1917 (Wolf.)—No further news has been received concerning this comet and we fear that it has been lost in the moonlight nights which followed the last observation. The observation which was made on September 21 is reported to have been made by Professor Schorr, presumably at Hamburg.

Comet *b* 1916 (Wolf).—On the night of October 15, this comet was visible, but not at all conspicuous in our 5-inch finder. In the 16-inch telescope it was nearly round, about 2′ in diameter, with a small central condensation but no stellar nucleus. The central condensation was not brighter than magnitude 12.0.

Mr. V. M. Slipher, of the Lowell Observatory, obtained a photograph of the spectrum of this comet on the nights of August 25 and 26, 1917. He describes it as chiefly a continuous spectrum. "Even the strongest cometary emissions are faint; the cyanogen band at 3883 is weak and the hydrocarbon band 4737 only a trace. The spectrum is too narrow and faint to decide definitely the presence of solar lines, but it indicates that the comet was shining by reflected sunlight."

The comet has been following the ephemeris which was computed by Crawford and Alter (published in the L. O. Bulletin No. 295 and in POPULAR ASTRONOMY) very closely, the deviation on August 30 being only +7ˢ.6 and +18″. It will continue to be visible for some months yet.

Ephemeris of Comet *b* 1916 (Wolf.)

[Continued from page 551. From the *Lick Observatory Bulletin* No. 295.]

1917 G.M.T.	True α	True δ	log Δ	Br.
	h m s	° ′ ″		
Dec. 1.5	0 04 55.9	−8 41 36	0.3481	
2.5	05 46.3	40 51		
3.5	06 37.2	39 55	0.3564	0.23
4.5	07 28.7	38 49		
5.5	08 20.7	37 33	0.3646	
6.5	09 13.2	36 07		
7.5	10 06.2	34 31	0.3727	0.21
8.5	10 59.7	32 46		
9.5	11 53.7	30 52	0.3807	
10.5	12 48.2	28 49		
11.5	13 43.2	26 37	0.3887	0.19
12.5	14 38.7	24 17		
13.5	15 34.6	21 48	0.3965	
14.5	16 31.0	19 11		
15.5	17 27.8	16 26	0.4042	0.17
16.5	18 25.0	13 34		
17.5	19 22.7	10 35	0.4118	
18.5	20 20.8	07 28		
19.5	21 19.3	04 15	0.4193	0.16
20.5	22 18.2	−8 00 55		
21.5	23 17.4	−7 57 29	0.4267	
22.5	24 17.0	53 56		
23.5	25 17.0	50 18	0.4340	0.14
24.5	26 17.3	46 34		
25.5	27 18.0	42 44	0.4412	
26.5	28 19.0	38 49		
27.5	29 20.3	34 48	0.4483	0.13
28.5	30 21.9	30 42		
29.5	31 23.9	26 32	0.4553	
30.5	32 26.2	22 17		
Dec. 31.5	0 33 28.7	−7 17 57	0.4622	0.12

Search Ephemeris for Encke's Comet for December, 1917.

Perihelion passage March 25.50 1918, G. M. T.

1917 Gr. Midnight	α	δ	log *r*	log Δ
	h m s	° ′ ″		
Dec. 3	22 47 35	+3 07 07	0.28726	0.20805
7	22 47 47	+2 57 33	0.27712	0.21239
11	22 48 33	+2 51 23	0.26652	0.21642
15	22 49 49	+2 48 49	0.25546	0.22002
19	22 51 34	+2 49 42	0.24384	0.22305
23	22 53 47	+2 53 55	0.23166	0.22550
27	22 56 24	+3 01 20	0.21884	0.22730
31	22 59 33	+3 12 01	0.20537	0.22841

FRANK E. SEAGRAVE.

Ephemeris of the Asteroid (15) Eunomia for the Opposition of February 7, 1918.

1918	α	δ	log *r*	log Δ
	h m s	° ′ ″		
Feb. 2	9 27 17	+7 00 13	0.43656	0.24535
6	9 23 12	+7 04 02	0.43776	0.24572
10	9 19 8	+7 08 52	0.43892	0.24719
14	9 15 7	+7 14 50	0.44010	0.24987
18	9 11 17	+7 21 28	0.44128	0.25371
22	9 07 39	+7 28 31	0.44240	0.25852
26	9 03 21	+7 40 50	0.44356	0.26511

Opposition February 7, 1918

FRANK E. SEAGRAVE.

The Asteroid (471) Papagena.—The asteroid (471) Papagena will be bright enough in November for those who are interested to follow it with small telescopes. The predicted magnitude at opposition November 17 is 8.4. The asteroid was observed on October 7 and 9 by Professor Edison Pettit of the Washburn College Observatory, Topeka, Kansas. He gives the magnitude on those dates as 9.0.

The following ephemeris is published in No. 719 of the *Astronomical Journal*, having been computed by Gustav Strömberg, of the Mount Wilson Solar Observatory.

EPHEMERIS OF THE ASTEROID (471) PAPAGENA.

	α App.	δApp.	log r	log Δ	Mag.
1917	h m s	° ′ ″			
Nov. 2	3 45 12.7	+3 30 19	0.3452	0.1015	
6	41 36.5	3 40 36			
10	37 46.4	3 53 38	0.3460	0.0969	8.4
14	33 47.8	4 09 24			
18	29 46.5	4 27 58	0.3470	0.0980	
22	25 48.1	4 49 19			
26	21 58.1	5 13 24	0.3481	0.1048	
30	18 21.4	5 40 15			
Dec. 4	15 02.1	6 09 31	0.3494	0.1169	
8	12 03.9	6 40 52			
12	09 30.7	7 14 12	0.3508	0.1335	
16	07 25.6	7 49 25			
20	05 50.4	8 26 13	0.3524	0.1537	
24	04 46.1	9 04 20			
28	3 04 11.5	+9 43 31	0.3541	0.1764	8.8

NOTES FOR OBSERVERS.

Monthly Report of the American Association of Variable Star Observers, September-October, 1917.

It is a pleasure to note in this the last report of our fiscal year, and the conclusion of six years work, the best record that we have yet attained for a monthly and yearly output of observations and the number of Variables observed in any one month or year.

This continuing evidence of growth and achievement should be a cause of pride and congratulation to all concerned and we should feel greatly encouraged over the future prospects of the Association.

Lists of exceptional merit were contributed this month by Messrs. Bancroft, Bouton, Luyten, and McAteer. Mr. Bancroft's list of 369 observations of 177 stars is the best list that has been contributed to the Association records. We congratulate Mr. Bancroft for this splendid example of zeal and interest.

We welcome Mr. David Wilson's return to the ranks of active observers this month. Monsieur Houdard, in spite of the handicaps of service at the Front, contributes this month a number of observations of naked eye Variables. Seventy-two observers have signed the Constitution and are now charter members of the formal organization.

VARIABLE STAR OBSERVATIONS Sept.-Oct., 1917.

September 0 = 2421472 October 0 = 2421502

001032

S Sculptoris

J.D. 242	Est.	Obs.
1478.7	<12.0	Ba

001046

X Androm.

1482.6	<13.3	Ba
83.6	<12.5	Bu
92.5	<13.2	B
95.6	15.1	M
95.7	15.2	Ba

001726

T Androm.

1483.6	<10.7	Bu
84.6	<13.0	Ba
93.6	<12.3	Wh
95.6	13.5	M
95.7	13.7	Ba

001755

T Cassiop.

1411.5	8.9	Lt
12.5	8.8	Lt
22.5	8.7	Lt
27.4	8.8	Lt
32.4	8.8	Lt
76.6	8.1	B
82.6	8.6	O
83.6	8.6	S
83.7	9.1	R
84.6	7.8	Ba
85.5	8.4	B
85.8	9.0	M
90.6	9.3	Bu
90.8	9.2	M
95.6	8.8	O
1500.8	9.3	M
02.6	7.9	Ba
08.6	8.8	O

001838

R Androm.

1411.5	8.0	Lt
12.5	7.9	Lt
16.4	7.9	Vo
16.5	7.5	Lt
17.4	7.5	Lt
21.5	7.6	Lt
25.5	7.5	Lt
30.5	7.5	Lt
32.5	7.5	Lt
36.4	7.5	Lt
40.4	7.5	Lt
51.3	7.4	Pe
52.4	7.5	Pe
53.3	7.5	Pe
57.3	7.5	Pe
58.3	7.7	Pe
59.3	7.7	Pe
62.3	7.8	Pe

R Androm.

J.D. 242	Est.	Obs.
1463.3	7.9	Pe
65.3	7.8	Pe
66.3	7.8	Pe
82.6	8.1	Hu
82.6	8.6	De
83.6	9.2	Bu
84.6	8.6	Ba
85.7	8.5	B
88.6	8.9	O
88.7	8.8	V
90.8	7.2	M
95.7	9.6	V
1508.6	9.4	O

001909

S Ceti

1489.8	9.0	M
90.6	8.6	Bu
94.7	8.8	Wh

002614

T Piscium

1495.8	10.2	M

003179

Y Cephei

1484.6	10.0	Ba
87.7	10.4	Wh
91.6	10.0	Hu
91.7	9.8	Wh
95.8	10.3	M

004047

U Cassiop.

1411.5	10.3	Lt
12.5	10.6	Lt
13.4	10.7	Lt
22.5	11.1	Lt
25.5	11.3	Lt
32.4	11.9	Lt
57.3	<11.1	Pe
58.3	<12.2	Pe
76.6	<12.1	De
83.6	<12.2	Bu
84.6	<13.2	Ba
91.6	<12.2	Wh
93.6	<13.0	B
94.6	<12.8	De
95.6	15.0	M
95.6	15.0	Ba

004181

RX Cephei

1412.5	7.5	Lt
16.5	7.4	Lt
40.4	7.4	Lt

004132

RW Androm.

J.D. 242	Est.	Obs.
1483.6	<12.6	Bu
84.6	<13.7	Ba
85.7	12.8	B
95.8	<11.5	M
97.6	<11.5	Wh

004435

V Androm.

1482.6	<12.6	Hu
83.6	<12.0	Bu
84.6	<13.6	Ba
96.8	<11.4	M

004535

RR Androm.

1425.5	9.6	Lt
27.4	9.5	Lt
30.5	9.4	Lt
33.4	9.3	Lt
83.6	10.7	Bu
84.6	10.4	Ba
88.6	10.8	O
95.8	10.4	M

004746

RV Cassiop.

1484.6	10.5	Ba
86.6	11.2	Re
86.6	11.2	Bu
88.6	11.0	Wh

004958

W Cassiop.

1411.5	9.3	Lt
12.5	9.4	Lt
21.5	9.3	Lt
27.4	9.3	Lt
32.5	9.3	Lt
33.4	9.3	Lt
76.6	8.4	B
82.6	9.0	O
84.6	8.8	Ba
85.5	8.5	B
85.8	9.0	M
86.6	9.3	Re
86.6	9.0	Bu
88.6	9.0	O
88.7	9.0	Wh
91.6	8.8	Ba
95.6	9.1	O
1500.6	8.5	B
04.6	9.1	O
08.6	9.5	O

010102

Z Ceti

1486.6	9.0	Re
86.6	9.0	Bu
94.7	8.8	Wh

010940

U Androm.

J.D. 242	Est.	Obs.
1484.6	10.7	Ba
86.6	10.8	Re
86.6	11.0	Bu

011208

S Piscium

1484.6	<13.0	Ba
86.6	12.0	Re
88.7	<11.3	V
94.7	<14.0	B

011272

S Cassiop.

1484.7	<10.4	R
85.5	13.4	B
85.8	<12.3	M
86.6	<12.3	Re
86.6	<12.3	Bu
91.7	<12.3	Wh
93.6	<12.5	B
95.5	14.6	Ba
95.6	14.7	M

011712

U Piscium

1482.8	<11.2	M
86.6	<12.3	Re

012350

RZ Persei

1486.6	12.0	Re
86.6	11.9	Bu

012502

R Piscium

1482.8	9.1	M
86.6	9.5	Re
86.6	9.5	Bu
94.7	9.8	De

013238

RU Androm.

1484.7	10.2	R
86.6	10.4	Re
86.6	10.6	Bu
89.8	10.5	M

013338

Y Androm.

1427.5	10.2	Lt
32.5	9.8	Lt
86.6	10.2	Re
86.6	10.6	Bu
93.8	11.0	M

014958

X Cassiop.

1476.6	10.1	B
82.8	<10.3	M
85.6	10.1	B
85.8	11.4	M
91.6	11.0	Ba
94.8	11.0	M
97.6	11.2	B

015354

U Persei

J.D. 242	Est.	Obs.
1337.4	10.3	Lt
41.4	10.3	Lt
75.5	10.4	Lt
1400.5	10.1	Lt
06.5	9.9	Lt
11.5	9.7	Lt
12.5	9.6	Lt
16.5	9.2	Lt
21.5	8.9	Lt
22.5	8.7	Lt
30.5	8.7	Lt
40.4	8.6	Lt
53.6	8.5	D
82.7	7.9	De
85.7	8.2	B
88.7	8.5	V
91.6	8.1	Ba
93.7	8.3	Wh
94.9	8.2	M
95.7	8.9	V
1500.7	8.2	B
02.6	7.9	Ba

015912

S Arietis

1482.7	<11.1	De
84.6	<13.9	B
90.6	<11.6	Re
90.6	<11.6	Bu
92.7	<12.3	De
94.7	14.0	B

021024

R Arietis

1490.6	9.8	Re
90.6	9.6	Bu
91.6	9.2	Ba
93.8	9.0	M

021143a

W Androm.

1390.5	9.0	Lt
96.5	9.2	Lt
1400.5	9.2	Lt
06.5	9.4	Lt
11.5	9.5	Lt
21.5	9.9	Lt
25.5	10.1	Lt
30.5	10.2	Lt
32.5	10.5	Lt
90.6	<11.2	Bu
98.6	<11.2	Wh

021281

Z Cephei

1475.6	11.6	Ba
88.7	11.3	V
95.7	10.9	V

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

021403
o Ceti

J.D. 242	Est.	Obs.
1469.6	5.5	L
78.7	4.5	Ba
81.6	4.1	L
83.7	3.9	Ba
89.8	3.8	M
90.6	3.8	D
81.6	3.9	Pi
94.7	3.3	De
95.7	3.5	M

021558
S Persei

1485.6	9.3	B
85.8	10.6	M
90.6	10.5	Bu
91.6	9.4	Ba
1502.6	9.3	Ba

021255
SU Persei

1416.4	8.1	Vo

022150
RR Persei

1482.7	12.1	Ba
90.6	11.8	Bu
94.9	11.0±	M

022813
U Ceti

1482.7	8.4	Ba
95.8	8.5	M

023080
RR Cephei

1475.6<12.0		Ba
88.7<11.0		V
95.7<11.0		V

023133
R Trianguli

1406.5	9.2	Lt
11.5	9.0	Lt
12.5	8.9	Lt
16.5	8.9	Lt
21.5	8.8	Lt
25.5	8.5	Lt
30.5	8.4	Lt
32.5	8.4	Lt
40.4	8.1	Lt
82.	6.3	T
82.7	6.5	Ba
83.8	6.0	M
90.	6.3	T
90.6	7.4	Bu
91.6	6.5	Ba
93.9	6.7	M
95.	6.3	T
1500.8	6.8	M
02.6	6.5	Ba

024217
T Arietis

J.D. 242	Est.	Obs.
1469.6	9.6	L

024356
W Persei

1473.8	10.4	M
78.7	10.0	Ba
82.7	9.3	Ba
82.8	10.0	M
90.6	10.2	Bu
91.6	9.5	Hu
91.6	9.0	Ba
93.7	9.3	Wh
1500.8	9.4	M
02.6	8.7	Ba

025840
β Persei

1457.3	3.1	Hd
62.4	3.1	Hd
63.4	3.1	Hd

030514
U Arietis

1482.7	14.7	Ba
94.6	13.8	Ba

031401
X Ceti

1493.8	9.6	M

032043
Y Persei

1476.6	8.5	B
78.7	8.5	Ba
82.7	8.3	Ba
83.7	8.6	De
85.7	8.4	B
91.6	8.1	Bu
91.6	8.4	Ba
1500.8	9.4	M
02.6	8.7	Ba

032335
R Persei

1421.6	9.1	Lt
25.5	8.9	Lt
30.5	8.9	Lt
33.5	8.8	Lt
82.7	11.0	Ba
83.7	11.0	De
85.8<10.4		M
91.6	11.5	Bu
93.8	12.5	M
94.6<10.1		S
94.7	11.5	Wh

033362
U Camelop.

1411.4	7.9	Lt
22.5	8.0	Lt
33.5	8.0	Lt

U Camelop.

J.D. 242	Est.	Obs.
1440.4	8.0	Lt
82.7	7.1	Ba
83.7	8.6	Pi
83.8	8.1	M
91.6	8.3	Bu
91.6	7.0	Ba
94.6	8.5	De
1502.6	7.2	Ba

041619
T Tauri

1482.8	9.5	M
94.9	9.9	M
98.9	10.0	M

042215
W Tauri

1482.7	9.1	Ba
82.8	9.9	M
83.7	10.0	Pi
98.8	9.7	M
1500.8	9.5	M

042209
R Tauri

1482.8<12.0		M

042309
S Tauri

1482.8<12.0		M

043065
T Camelop.

1411.4	8.7	Pe
22.5	9.3	Pe
32.5	9.4	Pe
33.5	9.4	Pe
82.8	11.3	M
98.7<11.5		Wh

043208
RX Tauri

1483.7<10.6		Pi
93.8	11.3	M

043274
X Camelop.

1411.4	9.7	Lt
12.5	10.0	Lt
13.5	10.0	Lt
17.5	10.6	Lt
21.5	11.0	Lt
22.5	11.2	Lt
25.5	11.5	Lt
30.5	12.2	Lt
33.5	12.3	Lt
80.6	9.0	Cr
82.7	10.1	Ba
82.8	10.0	M
83.7	9.9	Pi
87.7	9.8	Wh
89.5	9.2	Ba
95.8	8.6	V

RX Camelop.

J.D. 242	Est.	Obs.
1505.5	8.5	O
08.6	8.2	O

044617
V Tauri

1485.8	9.6	M

045514
R Leporis

1482.6	9.2	L
88.9	9.0	M

050022
T Leporis

1493.9	9.8	M

050003
V Orionis

1493.9<12.3		M

050953
R Aurigae

1425.5	9.3	Lt
30.5	9.3	Lt
85.8	8.6	M
1500.8	8.4	M
02.6	7.9	Ba

052405
S Orionis

1488.9<10.2		M
93.9	11.0	M

053068
S Camelop.

1411.5	8.9	Lt
22.5	8.5	Lt
33.5	8.2	Lt
82.8	8.6	M
94.6	8.8	De
98.7	8.8	Wh

*053005*a
T Orionis

1469.6<11.0		L
88.9	10.1	M
93.9	10.2	M

053326
RR Tauri

1483.8<11.3		M
88.9	11.5	M

052034
S Aurigae

1483.8	9.6	M
98.8	9.4	M

053531
U Aurigae

1485.8<10.4		M
95.8<11.0		V

054319
SU Tauri

J.D. 242	Est.	Obs.
1469.6	9.4	L
95.8	9.3	V

054974
V Camelop.

1425.5	12.0	Lt
30.5	12.1	Lt
32.5	12.1	Lt
80.6<12.6		Cr
82.7	13.2	Ba
82.8<11.3		M
88.7<12.2		Wh
89.5	13.5	Ba
93.9<11.3		M
98.7<11.6		Wh
1505.5<13.2		Ba

054920
U Orionis

1485.8	8.8	M
93.9	9.0	M
96.8	9.2	M

055353
Z Aurigae

1488.9	9.7	M
1500.8	9.5	M

060450
X Aurigae

1483.7	10.3	Pi
85.8	10.4	M
94.7	9.7	De
95.8	9.1	V

060547
SS Aurigae

1467.6<12.4		L
69.6<12.4		L
82.6<11.3		L
83.7<11.4		Pi
90.7<13.5		B
90.7<12.4		Pi
92.7<11.4		Pi
93.7<12.4		Pi
93.9<12.4		M
94.7<13.8		B
94.7<12.4		De
95.8<11.6		V
96.8<11.8		M

061647
V Aurigae

1496.8	10.0	M

061702
V Monoc.

1496.8	8.8	M

063308
R Monoc.

1496.8	10.6	M

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

063558
S Lyncis

J.D 242	Est.	Obs.
1493.9	10.2	M

064030
X Gemin.

1493.9	<11.2	M

065208
X Monoc.

1493.9	9.5	M

*070122*a
R Gemin.

1500.8	6.4	M

070122 b
Z Gemin.

1500.8	<10.8	M

070122c
TW Gemin.

1500.8	8.2	M

071713
V Gemin.

1493.9	<11.4	M

072708
S Can. Min.

1494.9	8.6	M

072811
T Can. Min.

1494.9	<9.9	M

073508
U Can. Min.

1469.6	<10.7	L

073723
S Gemin.

1485.9	<10.1	M
93.9	<11.5	M

074323
T Gemin.

1493.9	<11.5	M

074922
U Gemin.

1469.6	<10.9	L
93.9	<11.3	M

090151
V Urs. Maj.

1467.6	10.5	L
69.6	10.5	L

103769
R Urs. Maj.

1400.5	10.7	Lt
06.5	10.2	Lt
11.4	9.7	Lt
12.5	9.6	Lt
13.5	9.5	Lt
16.5	9.2	Lt
21.5	9.0	Lt
22.5	8.9	Lt
25.5	8.8	Lt
30.5	8.0	Lt

R Urs. Maj.

J.D 242	Est.	Obs.
1433.5	7.9	Lt
40.4	7.7	Lt
62.3	7.4	Pe
63.3	7.3	Pe
65.3	7.3	Pe
66.3	7.4	Pe
72.6	7.7	B
81.6	7.6	M
82.5	7.9	Ba
89.5	8.2	Ba
90.5	8.0	B
94.9	8.0	M
1502.5	8.2	Ba

122532
T Can. Ven.

1483.5	<11.5	Ba

123160
T Urs. Maj.

1457.3	11.2	Pe
58.3	11.9	Pe
59.3	11.6	Pe
62.3	11.5	Pe
66.3	10.2	Pe
81.6	8.7	M
82.5	8.4	Ba
82.6	8.4	Bu
82.6	8.5	Re
82.6	8.4	B
89.5	7.9	Ba
93.6	7.8	B
1502.5	7.4	Ba

123307
R Virginis

1400.4	10.9	Lt
06.4	10.6	Lt
11.4	10.2	Lt
17.4	9.8	Lt

123459
RS Urs. Maj.

1458.3	<12.6	Pe
59 3	<12.6	Pe
62.3	<12.8	Pe
66.3	<12.6	Pe
82.5	<13.5	Ba
82.6	<11.8	Re
82.6	<11.8	Bu
82.6	13.6	B
93.6	<13.5	B

123961
S Urs. Maj.

1411.4	10.5	Lt
12.5	10.5	Lt
13.5	10.4	Lt
21.5	10.6	Lt
30.5	10.7	Lt

S Urs. Maj.

J.D 242	Est.	Obs.
1432.5	10.8	Lt
48.3	11.1	Pe
57.3	11.8	Pe
58.3	11.4	Pe
59.3	11.4	Pe
62.3	11.4	Pe
66.3	11.4	Pe
81.3	10.4	L
81.6	10.1	M
82.5	9.9	Ba
82.6	10.5	Re
82.6	10.7	Bu
82.6	10.1	We
89.6	9.0	Ba
91.6	9.0	B
93.6	9.6	Wh
93.6	8.8	B

124146
Y Can. Ven.

1411.4	5.6	Vo
16.4	5.6	Vo

124606
U Virginis

1411.4	9.0	Lt

131546
V Can. Ven.

1411.4	8.6	Vo
11.4	8.5	Lt
12.5	8.5	Lt
13.5	8.4	Lt
22.5	8.4	Lt
30.5	8.4	Lt
40.4	8.4	Lt

133273
T Urs. Min.

1412.5	9.6	Lt
21.5	10.0	Lt
22.5	10.1	Lt
30.5	11.0	Lt
32.5	11.2	Lt
81.6	11.8	M
82.5	12.4	Ba
89.6	12.4	Ba
93.6	<11.4	V

134440
R Can. Ven.

1412.5	11.0	Lt
17.4	10.9	Lt
25.4	10.3	Lt
30.5	10.0	Lt
77.3	8.7	L
81.6	8.4	M
83.5	8.5	Ba
89.6	8.5	Ba
1502.5	8.3	Ba

140113
Z Bootis

J.D 242	Est.	Obs.
1411.4	10.6	Lt
21.4	10.2	Lt
22.4	10.1	Lt
25.4	10.0	Lt
30.4	9.9	Lt
82.5	12.0	Ba

141567
U Urs. Min.

1406.5	11.2	Lt
16.5	10.8	Lt
25.5	10.5	Lt
32.4	10.2	Lt
81.6	8.8	M
82.5	8.7	Ba
82.6	8.8	B
83.6	8.9	S
89.6	8.5	Ba
91.6	9.1	De
1502.5	8.4	Ba

141954
S Bootis

1477.6	<13.3	B
81.6	<10.6	M
82.5	13.3	Ba
83.6	<11.6	Pi
89.6	<13.0	Ba
92.5	<12.0	De

142205
RS Virginis

1411.4	9.3	Lt
16.4	9.4	Lt

142539
V Bootis

1411.4	9.6	Lt
12.5	9.6	Lt
13.5	9.6	Lt
21.5	9.8	Lt
22.4	9.8	Lt
30.5	10.1	Lt
32.4	10.1	Lt
69.4	10.4	L
77.6	10.8	O
78.3	10.6	L
81.6	9.8	We
81.6	10.2	M
82.5	10.4	Ba
83.5	10.2	B
83.6	10.1	Pi
89.6	10.1	Ba
91.5	10.6	De
1502.5	10.0	Ba

142584
R Camelop.

J.D 242	Est.	Obs.
1481.6	<10.8	M
82.5	10.3	B
82.5	10.2	Ba
89.6	9.6	Ba
97.5	9.2	B
1502.5	8.7	Ba
08.6	9.1	O

143227
R Bootis

1406.6	10.7	Lt
12.5	10.4	Lt
21.5	10.0	Lt
22.4	9.9	Lt
25.4	9.5	Lt
30.5	9.4	Lt
69.3	7.7	L
71.3	7.1	Pe
77.6	7.0	O
78.3	6.5	L
81.6	7.1	M
82.5	6.3	Ba
82.6	7.0	O
82.6	6.8	R
83.6	7.0	Pi
83.6	7.0	B
89.6	6.5	Ba
1502.5	7.3	Ba

144918
U Bootis

1412.4	11.2	Lt
21.4	11.1	Lt
22.4	11.4	Lt
25.4	11.5	Lt
30.4	11.5	Lt
76.6	10.1	V
82.5	10.5	Ba
84.5	10.5	B
95.5	10.3	B

151714
S Serpentis

1406.5	11.4	Lt
11.4	10.9	Lt
12.5	10.7	Lt
16.5	10.4	Lt
21.5	9.9	L
30.5	9.3	Lt
32.4	9.1	Lt
76.6	9.1	V
82.5	8.8	Ba
89.6	9.1	Ba
92.5	9.3	De

151731
S Coronae

1406.4	11.2	Lt
17.4	11.5	Lt
30.4	12.0	Lt
33.4	11.9	Lt
81.6	<10.3	We

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

S Coronae

J.D. 242	Est.	Obs.
1482.6	12.3	Ba
83.6	<10.3	Pi
83.6	12.6	B
89.6	12.8	Ba
91.5	12.3	B

153378
S Urs. Min.

J.D. 242	Est.	Obs.
1422.5	10.4	Lt
30.5	10.7	Lt
81.6	<10.6	We
82.6	10.4	Ba
82.6	10.5	R
82.6	10.5	B
83.6	11.4	Wpi
87.6	10.3	B
89.6	10.4	Ba
1502.6	10.3	Ba

154428
R Cor. Bor.

J.D. 242	Est.	Obs.
1411.4	<9.3	Vo
11.4	12.1	Lt
13.5	11.7	Lt
16.5	11.3	Lt
17.4	11.2	L
21.5	10.5	Lt
22.5	10.4	Lt
25.4	10.5	Lt
27.4	10.2	Lt
30.4	9.8	Lt
32.4	9.7	Lt
33.4	9.7	Lt
40.4	9.8	Lt
53.4	12.4	L
59.4	<12.2	Pe
62.4	<13.1	Pe
63.4	<13.1	Pe
64.4	<12.6	L
72.6	<12.6	B
76.3	<12.6	L
76.4	<11.4	V
76.6	<13.2	B
77.6	<10.7	O
77.6	<12.2	Hu
77.6	12.6	Wh
77.6	<12.2	Cr
77.6	13.4	B
78.3	<12.3	L
78.6	<13.1	Ba
78.6	<13.3	B
80.6	13.5	B
80.6	<10.7	Rd
81.3	<12.6	L
81.6	<10.7	Pi
81.6	<11.3	M
81.6	<12.5	Hu
82.3	<12.6	L
82.5	13.6	Ba
82.6	<11.4	Re

R Cor. Bor.

J.D. 242	Est.	Obs.
1482.6	<10.7	O
82.6	13.4	B
82.6	<11.0	R
82.6	<11.4	Bu
83.5	13.4	B
83.5	13.5	Ba
83.6	<11.4	Pi
83.6	<10.7	S
83.7	<11.0	R
84.5	13.6	Ba
84.5	13.4	B
84.6	<10.7	Rd
84.7	<11.0	R
85.5	13.4	B
86.5	13.4	B
86.7	<10.5	R
88.5	13.4	B
89.5	13.7	Ba
89.6	12.8	Me
89.7	<10.7	R
90.5	13.4	B
90.6	<10.7	Rd
91.5	<13.2	Ba
92.5	13.4	B
93.5	13.3	B
93.6	14.1	M
94.5	13.3	B
94.6	<11.4	V
95.5	13.4	B
95.6	14.2	Ba
97.5	<13.1	B
1500.5	13.3	B
02.5	<12.5	Ba
05.5	12.4	Ba

154536
X Cor. Bor.

J.D. 242	Est.	Obs.
1477.6	11.2	B
82.6	10.7	Ba
89.6	10.4	Ba
90.5	10.4	B
1502.6	10.2	Ba

154539
V Cor. Bor.

J.D. 242	Est.	Obs.
1481.6	9.8	M
82.6	8.3	Ba
83.6	9.1	Pi
89.6	8.3	Ba
1502.6	7.8	Ba

154615
R Serpentis

J.D. 242	Est.	Obs.
1411.4	9.0	Lt
12.4	9.0	Lt
16.5	9.3	Lt
17.5	9.3	Lt
21.5	9.5	Lt
22.4	9.5	Lt
30.4	9.9	Lt
32.5	10.2	Lt

R Serpentis

J.D. 242	Est.	Obs.
1458.4	11.0	Pe
63.4	11.4	Pe
82.6	12.5	Ba
86.6	12.6	B
89.6	12.6	Ba
91.5	12.6	B

155229
Z Cor. Bor.

J.D. 242	Est.	Obs.
1421.5	11.4	Lt
22.5	11.3	Lt
25.4	11.1	Lt
30.4	11.0	Lt
78.6	11.5	B
82.6	11.8	Ba
1500.6	<12.7	B

155823
RZ Scorpii

J.D. 242	Est.	Obs.
1483.5	11.5	Ba

155847
X Herculis

J.D. 242	Est.	Obs.
1411.5	6.3	Lt
12.4	6.3	Lt
13.4	6.4	Lt
16.4	6.4	Lt
17.4	6.3	Lt
21.4	6.3	Lt
22.4	6.4	Lt
25.4	6.4	Lt
27.4	6.4	Lt
30.4	6.3	Lt
32.4	6.4	Lt
33.4	6.4	Lt
40.4	6.4	Lt
66.3	6.8	Pe
79.7	6.2	Mu
82.6	6.5	Ba
82.6	6.9	O
82.8	6.4	Mu
84.7	6.4	Mu
86.6	7.0	Rd
86.7	6.5	Mu
87.7	6.5	Mu
88.8	6.5	Mu
89.7	6.5	Mu
94.6	6.4	Nt
1502.6	6.4	Nt

160118
R Herculis

J.D. 242	Est.	Obs.
1476.6	<10.7	V
77.6	<12.5	Hu
77.6	<13.3	B
82.6	13.5	Ba
84.6	<11.5	De
91.6	13.5	B

160210
U Serpentis

J.D. 242	Est.	Obs.
1411.4	8.9	Lt
12.5	9.0	Lt
21.5	9.1	Lt
30.5	9.5	Lt
82.6	12.1	Ba
86.6	11.7	B
89.6	11.9	Ba
91.5	12.0	B

160325
SX Herculis

J.D. 242	Est.	Obs.
1411.4	8.6	Lt
12.4	8.6	Lt
21.5	8.7	Lt
22.4	8.7	Lt
30.5	8.8	Lt
40.4	8.7	Lt

160625
RU Herculis

J.D. 242	Est.	Obs.
1476.6	<10.9	V
77.6	13.4	B
82.6	<12.3	De
82.6	12.9	Ba
91.6	13.5	B

161122a
R Scorpii

J.D. 242	Est.	Obs.
1483.5	10.9	Ba

161122b
S Scorpii

J.D. 242	Est.	Obs.
1483.5	<12.0	Ba

161138
W Cor. Bor.

J.D. 242	Est.	Obs.
1477.6	12.2	B
82.6	12.0	Ba
83.6	<11.5	Pi
89.6	11.7	Ba
90.6	11.4	B

161607
W Ophiuchi

J.D. 242	Est.	Obs.
1482.6	12.5	Ba

162119
U Herculis

J.D. 242	Est.	Obs.
1411.4	9.9	Lt
12.5	9.8	Lt
21.5	9.4	Lt
22.4	9.4	Lt
30.5	9.1	Lt
77.6	8.6	Hu
77.6	8.7	O
79.7	8.4	Mu
82.6	8.1	Ba
82.6	8.5	De
82.6	8.5	We
82.6	9.0	O
82.6	9.1	R

U Herculis

J.D. 242	Est.	Obs.
1483.6	8.7	S
83.6	8.8	B
84.6	8.9	Rd
88.6	9.0	O
89.5	8.8	W
89.6	8.2	Ba
91.6	9.2	O
91.6	8.6	Wh
95.6	9.3	O
1500.6	8.9	B
02.6	8.7	Ba
04.6	9.2	O
08.6	9.4	O

162112
V Ophiuchi

J.D. 242	Est.	Obs.
1390.5	9.6	Lt
92.5	9.6	Lt
96.5	9.6	Lt
1400.5	9.6	Lt
06.5	9.6	Lt
21.5	9.6	Lt
82.6	7.8	Ba
90.5	7.3	B

162542
g Herculis

J.D. 242	Est.	Obs.
1411.4	4.8	Vo
11.5	5.2	Lt
12.4	5.2	Lt
13.4	5.1	Lt
16.4	5.0	Lt
17.4	5.0	Lt
21.4	4.9	Lt
22.4	5.0	Lt
25.4	4.8	Lt
27.4	4.7	Lt
30.4	4.7	Lt
31.4	4.7	Lt
32.4	4.7	Lt
33.4	4.8	Lt
36.4	4.9	Lt
40.4	5.0	Lt
66.3	5.1	Pe
79.7	4.8	Mu
82.8	4.9	Mu
84.7	5.0	Mu
86.7	5.1	Mu
87.7	5.0	Mu
88.8	5.0	Mu
89.7	5.1	Mu

162837
SS Herculis

J.D. 242	Est.	Obs.
1411.4	11.0	Lt
12.5	11.0	Lt
16.5	11.3	Lt
21.5	11.4	Lt
30.4	11.9	Lt
75.5	8.8	Ba

VARIABLE STAR OBSERVATIONS, Sept.-Oct. 1917—Continued.

SS Herculis

J.D. 242	Est.	Obs.
1476.3	8.9	L
77.6	9.0	Hu
82.5	8.8	Ba
84.6	8.9	Ba
85.6	9.5	De
86.6	9.2	B
89.5	9.3	Ba
91.5	9.6	Ba
91.6	9.7	Wh
93.6	10.1	V
1500.6	9.8	B
02.5	10.1	Ba
05.5	10.5	Ba

162816

S Ophiuchi

1483.5	10.5	Ba

163137

W Herculis

1477.6	9.1	Hu
82.6	8.7	Ba
82.6	8.7	B
83.6	8.6	S
85.6	8.6	De
89.6	8.5	Ba
92.6	8.2	De
1500.6	8.0	B
02.6	8.0	Ba

163172

R Urs. Min.

1482.6	9.0	B
82.6	9.3	Ba
88.6	10.4	O
89.6	9.4	Ba
91.7	9.5	Wh
95.7	10.2	M
97.6	9.6	B
1502.6	9.6	Ba

163266

R Draconis

1411.4	8.8	Lt
12.5	8.4	Lt
16.5	8.1	Lt
17.5	8.2	Lt
21.5	8.0	Lt
22.5	7.9	Lt
25.5	7.9	Lt
30.5	7.5	Lt
32.5	7.5	Lt
33.5	7.5	Lt
72.6	7.6	B
77.6	8.4	O
82.6	8.1	R
82.6	8.7	O
82.6	8.3	W
82.6	8.1	Ba
84.6	8.6	De

R Draconis

J.D. 242	Est.	Obs.
85.6	8.7	B
87.6	8.9	We
88.6	8.9	O
89.6	8.6	Ba
91.6	8.9	O
91.7	9.1	Wh
94.6	9.1	S
95.6	9.1	O
95.7	9.3	M
1500.6	9.4	B
02.6	9.4	Ba
04.6	9.4	O
08.4	9.4	O

164055

S Draconis

1411.4	8.5	Lt
12.5	8.5	Lt
25.5	8.5	Lt
40.5	8.6	Lt
82.6	8.5	Ba
84.6	8.4	W
91.7	8.5	Wh
95.7	9.1	M
1502.6	8.6	Ba

164319

RR Ophiuchi

1483.5	10.6	Ba
90.5	10.0	B

164715

S Herculis

1406.5	12.3	Lt
25.4	12.5	Lt
30.4	12.5	Lt
33.4	12.4	Lt
76.6	10.6	De
82.6	10.2	Ba
89.6	10.0	Ba
91.7	9.6	Wh
92.7	9.8	De
1500.6	9.2	B
02.6	9.1	Ba

165030

RR Scorpii

1483.7	8.5	R

165631

RV Herculis

1476.6	<12.2	De
77.6	12.3	Hu
82.6	13.1	Ba
91.6	13.1	B
91.6	<11.8	Wh
95.6	12.9	M
95.6	12.9	Ba

170215

R Ophiuchi

J.D. 242	Est.	Obs.
1482.6	12.5	Ba

170627

RT Herculis

1477.6	<13.0	B
82.6	<13.0	Ba
85.6	<11.2	De
91.6	<12.8	B

171401

Z Ophiuchi

1411.4	9.6	Lt
12.5	6.7	Lt
21.5	9.7	Lt
25.5	9.9	Lt
77.6	11.4	B
78.6	10.9	V
82.6	11.2	Ba
1500.5	11.8	B

171723

RS Herculis

1406.5	8.9	Lt
11.5	8.7	Lt
12.5	8.6	Lt
13.5	8.5	Lt
22.5	8.5	Lt
30.5	8.5	Lt
33.4	8.5	Lt
77.6	9.8	Hu
78.6	9.4	V
79.7	9.3	Mu
82.6	9.3	B
82.6	9.1	Ba
83.7	9.7	R
85.6	9.8	De
88.6	9.6	O
89.6	9.5	Ba
91.6	10.1	Wh
93.6	9.8	V
1500.6	10.5	B
02.6	10.1	Ba

172809

RU Ophiuchi

1478.6	13.1	B
82.6	13.2	Ba
83.7	<11.2	R
1500.6	<12.8	B

173457

TY Draconis

1458.3	9.0	Pe
59.4	9.1	Pe
66.3	9.1	Pe

175111

RT Ophiuchi

1482.6	<13.0	Ba
86.6	13.2	B
91.6	13.2	B

175315

Z Herculis

J.D. 242	Est.	Obs.
1455.3	7.0	L

175458

T Draconis

1482.6	11.3	B
95.7	9.2	M
1500.6	11.2	B

175519

RY Herculis

1482.6	11.2	B
82.6	11.0	Ba
85.6	11.1	De
90.6	10.5	B

180531

T Herculis

1411.4	8.5	Lt
12.4	8.6	Lt
17.5	9.0	Lt
21.5	9.3	Lt
25.5	9.6	Lt
32.4	10.5	Lt
77.6	12.1	Hu
82.6	11.8	Ba
82.6	11.6	De
82.6	11.0	We
83.6	<11.0	Sw
83.6	12.2	B
84.6	<9.8	Rd
91.6	11.6	Wh
92.6	12.0	±De
94.6	11.6	B
95.6	<11.0	Sw

180565

W Draconis

1482.6	12.7	B
82.6	<12.0	Ba
90.6	12.8	B
91.7	<12.0	Wh

180931

TV Herculis

1452.4	<12.0	L
59.4	<12.5	Pe
78.3	11.0	L
82.3	10.8	L

181103

RY Ophiuchi

1478.6	10.1	V
78.6	10.0	B
82.6	10.0	Ba
94.6	11.0	V
1500.6	11.8	B

181136

W Lyrae

1427.4	10.7	Lt
30.5	10.5	Lt
32.4	10.4	Lt
72.6	8.3	B

W Lyrae

J.D. 242	Est.	Obs.
1476.6	8.1	De
76.8	8.5	M
82.6	7.8	Ba
85.6	8.4	O
85.6	8.0	B
89.6	7.9	W
89.6	7.8	Ba
91.6	7.8	Wh
92.6	7.6	De
1500.6	7.8	B
02.6	7.6	Ba
04.6	8.6	O
08.6	8.0	O

182224

SV Herculis

1482.6	13.2	B
82.6	13.5	Ba
87.6	12.5	±De
94.6	12.8	B

182306

T Serpentis

1482.6	<13.0	Ba
90.6	<11.9	Bu

183225

RZ Herculis

1427.4	9.7	Lt
30.5	9.3	Lt
33.4	9.3	Lt
82.6	10.6	Ba
88.7	11.7	Wh
92.6	11.5	De

183308

X Ophiuchi

1411.4	8.0	Vo
11.4	8.1	Lt
12.5	8.0	Lt
16.4	7.9	Vo
16.5	8.0	Lt
21.5	8.0	Lt
22.5	8.0	Lt
25.4	7.9	Lt
30.5	7.9	Lt
40.4	7.8	Lt
76.4	6.9	L
76.5	6.9	De
77.6	6.9	B
78.6	6.8	V
82.6	6.4	Ba
88.6	7.1	Bu
89.6	6.6	Ba
91.5	7.2	De
94.6	7.6	V
1500.5	7.4	B
02.6	6.8	Ba

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

184134
RY Lyrae

J.D. 242	Est.	Obs.
1482.6	13.5	Ba
91.6	<12.3	Wh

184243
RW Lyrae

J.D. 242	Est.	Obs.
1482.6	14.0	B
82.6	<13.8	Ba
94.6	<14.0	B
1505.5	<13.9	Ba

184205
R Scuti

J.D. 242	Est.	Obs.
1411.4	5.7	Lt
11.4	5.5	Vo
12.4	5.5	Lt
13.4	5.4	Lt
14.3	5.9	Pe
16.4	5.6	Vo
16.5	5.5	Lt
17.4	5.5	Vo
17.4	5.6	Lt
21.4	5.7	Lt
22.3	5.9	Pe
22.4	5.9	Lt
23.3	5.9	Pe
23.4	6.0	Lt
24.3	5.9	Pe
25.3	6.0	Pe
25.4	6.0	Lt
27.3	6.0	Pe
27.4	6.0	Lt
28.3	6.0	Pe
30.4	6.1	Lt
32.3	6.2	Pe
32.5	6.1	Lt
33.5	6.1	Lt
36.3	6.0	Pe
36.4	6.2	Lt
37.4	6.2	Lt
38.4	6.1	Lt
40.4	6.0	Lt
48.3	5.6	Pe
49.3	5.6	Pe
51.3	5.6	Pe
53.3	5.5	Pe
53.4	5.2	L
54.3	5.4	Pe
57.3	5.1	Hd
58.3	5.6	Pe
62.4	5.5	Hd
63.3	5.5	Pe
63.4	5.5	Hd
64.4	5.1	L
66.4	5.8	Hd
71.3	5.3	L
75.5	6.0	Ba
76.6	5.9	Bu
76.6	5.6	Re
76.6	6.0	Ba
76.6	6.1	We

R Scuti

J.D. 242	Est.	Obs.
77.3	5.1	Be
77.6	5.8	Bu
77.6	5.8	O
77.6	6.1	We
77.6	5.6	Re
78.3	5.1	Be
78.6	6.1	Ba
79.7	6.1	Mu
81.6	6.1	We
82.3	5.2	Be
82.5	6.2	Ba
82.6	5.8	Re
82.6	6.2	Hu
82.6	6.1	O
82.6	6.4	R
82.6	6.2	Bu
82.8	6.2	Mu
83.5	6.2	Ba
83.7	6.8	R
84.5	6.3	Ba
84.6	5.9	Rd
84.7	6.4	Mu
84.7	6.9	R
85.6	6.7	O
86.6	7.0	Bu
86.7	7.0	R
86.7	7.0	Mu
87.7	6.9	Mu
88.6	6.8	O
89.5	6.4	Ba
89.7	7.2	Mu
89.7	7.3	R
90.6	6.8	Rd
90.6	6.9	Re
90.6	6.9	Bu
91.5	6.6	Ba
91.6	7.2	Re
91.6	7.2	Bu
94.6	6.4	We
94.6	7.0	Nt
95.5	6.8	Ba
95.6	6.9	M
95.6	6.9	Bu
97.6	7.0	Bu
1502.6	6.8	Nt
02.6	6.7	Ba
05.5	6.5	Ba

184433
β Lyrae

J.D. 242	Est.	Obs.
1457.3	3.6	Hd
60.3	3.5	Hd
62.4	4.1	Hd
63.4	3.5	Hd
66.4	3.4	Hd
70.3	3.5	Hd

185032
RX Lyrae

J.D. 242	Est.	Obs.
1482.6	<12.4	Ba

185243
R Lyrae

J.D. 242	Est.	Obs.
1411.4	4.3	Vo
11.6	4.2	Lt
12.4	4.2	Lt
13.4	4.2	Lt
15.4	4.4	Vo
16.4	4.2	Lt
17.4	4.2	Lt
17.4	4.4	Vo
21.4	4.2	Lt
22.4	4.3	Lt
25.4	4.3	Lt
27.4	4 2	Lt
30.4	4.2	Lt
32.4	4.2	Lt
33.4	4.3	Lt
36.4	4.3	Lt
38.4	4.3	Lt
40.4	4.3	Lt

185634
Z Lyrae

J.D. 242	Est.	Obs.
1482.6	13.4	Ba

190108
R Aquilae

J.D. 242	Est.	Obs.
1411.4	6.9	Vo
11.5	6.6	Lt
12.5	6.7	Lt
16.4	7.1	Vo
16.5	7.0	Lt
17.4	7.2	Vo
17.5	7.0	Lt
21.5	7.1	Lt
22.5	7.1	Lt
25.4	7.3	Lt
30.5	7.7	Lt
33.5	8.1	Lt
40.	8.5	Lt
76.3	9 4	L
83.5	9.6	Ba
83.6	9.1	B
83.6	9.4	V
91.5	10.2	Ba
91.6	9.8	Bu
94.6	10.9	V
97.6	9.8	B

190529
V Lyrae

J.D. 242	Est.	Obs.
1483.5	<13.5	Ba

190907
TY Aquilae

J.D. 242	Est.	Obs.
1475.5	11.0	Ba
83.5	11.2	Ba

190926
X Lyrae

J.D. 242	Est.	Obs.
1481.6	9.1	Pi
83.6	9.0	Ba
91.5	9.1	Ba
1502.6	9.0	Ba

190967
U Draconis

J.D. 242	Est.	Obs.
1475.6	10.2	Ba
83.6	9.9	Ba
84.6	9.6	Hu
91.5	9.8	Bu

191007
W Aquilae

J.D. 242	Est.	Obs.
1427.5	9.1	Lt
30.5	8.8	Lt
32.5	8.7	Lt
75.5	7.8	Ba
83.5	8.0	Ba
91.6	8.3	Bu

191017
T Sagittari

J.D. 242	Est.	Obs.
1477.3	11.8	L

191019
R Sagittarii

J.D. 242	Est.	Obs.
1480.6	13.0	B
83.6	12.5	Ba
90.6	12.6	B

191033
RY Sagittarii

J.D. 242	Est.	Obs.
1453.4	<10.2	L
64.4	9.6	L
76.3	9.5	L
76.6	9.8	Ba
77.3	9.5	L
81.3	9.6	L
82 3	9.0	L
82.5	9.3	Ba
83.5	9.3	Ba
83.7	9.3	R
84.7	9.4	R
89.5	9.8	Ba
89.7	9.6	R
91.5	9.8	Ba
1505.5	9.4	Ba

191350
TZ Cygni

J.D. 242	Est.	Obs.
1483.6	10.2	Ba
91.5	10.2	Ba
1502.6	10.2	Ba

191637
U Lyrae

J.D. 242	Est.	Obs.
1483.6	9.5	Ba
91.6	9.8	Ba
1502.6	9.3	Ba

192576
UX Draconis

J.D. 242	Est.	Obs.
1411.4	6.8	Lt
12.5	6.8	Lt
21.5	6.8	Lt
22.5	6.8	Lt
30.5	6.8	Lt
32.5	6.8	Lt

192743
AF Cygni

J.D. 242	Est.	Obs.
1411.4	7.3	Vo
11.5	6.8	Lt
12.5	6.9	Lt
13.4	7.0	Lt
16.4	7.1	Lt
16.4	7.3	Vo
17.4	7.3	Vo
21.4	7.2	Lt
22.4	7.4	Lt
27.4	7.6	Lt
30.4	7.6	Lt
32.4	7.6	Lt
37.4	7.5	Lt
40.4	7.6	Lt

192928
TY Cygni

J.D. 242	Est.	Obs.
1483.6	<13.5	Ba

193311
RT Aquilae

J.D. 242	Est.	Obs.
1483.6	13.3	Ba
91.6	<12.8	Bu

193449
R Cygni

J.D. 242	Est.	Obs.
1411.5	11.9	Lt
12.4	11.8	Lt
16.4	11.7	Lt
17.4	11.7	Lt
21.4	11.6	Lt
25.4	11.5	Lt
27.5	11.4	Lt
30.4	11.3	Lt
33.4	11.2	Lt
76.6	7.6	De
81.6	7.9	Hu
82.7	8.6	R
82.8	8.0	M
83.6	8.4	S
83.6	7.3	Ba
91.6	7.6	Ba
91.6	8.5	De
1502.6	7.5	Ba

193509
RV Aquilae

J.D. 242	Est.	Obs.
1483.6	12.3	Ba
90.6	12.3	Wh
91.6	12.5	Bu

193732
TT Cygni

J.D. 242	Est.	Obs.
1481.6	7.3	Hu
83.6	7.6	Ba
91.6	7.4	Ba
1502.6	7.1	Ba

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

194048
RT Cygni

J.D. 242	Est.	Obs'
1411.5	8.5	Lt
12.4	8.6	Lt
13.4	8.7	Lt
16.4	8.8	Lt
21.4	9.0	Lt
27.4	9.2	Lt
33.4	9.2	Lt
33.4	9.5	Lt
81.6	11.9	Hu
82.8	<10.8	M
83.6	< 9.8	S
83.6	11.8	Ba
91.6	11.0	Ba
91.6	11.2	De
1502.6	9.9	Ba

194348
TU Cygni

1481.6	9.9	Hu
82.8	10.6	M
83.6	10.3	Ba
91.6	10.1	Ba
1502.6	10.4	Ba

194604
X Aquilae

1483.6	13.3	B
83.6	13.4	Ba
90.6	<12.2	Wh
91.6	<12.3	Bu
91.6	13.5	B

194632
χ Cygni

1411.5	11.0	Lt
12.4	11.0	Lt
13.4	11.1	Lt
16.4	11.3	Lt
17.4	11.4	Lt
21.4	11.5	Lt
22.4	11.5	Lt
25.4	11.6	Lt
30.4	11.6	Lt
32.4	11.7	Lt
33.4	11.7	Lt
75.6	<12.5	Ba
83.6	12.5	Ba
90.6	<12.2	Me
91.6	12.8	Ba

194700
η Aquilae

1420.3	4.1	Be
53.3	3.7	L
55.3	4.0	L
62.4	4.4	Hd
63.4	4 4	Hd
64.3	4.0	L
69.3	4.0	L
71.3	4.0	L
76.3	4.0	L

η Aquilae

J.D. 242	Est.	Obs.
1477.3	4.0	Be
77.3	4.2	L
78.3	4.2	Be
78.3	4.1	L
81.3	3.9	L
82.3	4.2	Be
82.3	3.8	L

195116
S Sagittae

1420.3	5.6	Be
23.3	5.4	Be
25.3	5.4	Be
53.3	5.8	L
55.3	5.3	L
64.3	5.3	L
67.3	5.9	L
76.3	5.9	L
77.3	6.0	Be
77.3	6.0	L
77.6	6.1	O
78.3	5.8	L
78.3	6.1	De
79.7	5.1	Mu
81.3	5.3	L
82.3	5.2	L
82.3	5.3	Be
82.6	5.5	R
82.6	5.6	O
82.8	5.4	Mu
83.7	5.6	R
84.5	5.5	Rd
84.7	5.8	Mu
84.7	6.1	R
85.6	6.0	O
86.7	5.8	Mu
87.7	5.4	Mu
88.6	5.6	O
88.8	5.3	Mu
89.7	5.3	Mu
91.5	5.5	Rd
91.6	5.5	O
92.5	5.7	Rd
93.5	5.9	Rd
94.6	6.0	Rd
95.6	5.9	O
95.6	6.0	Rd
1504.6	5.5	O
08.6	5.8	O
09.6	5.8	O

195849
Z Cygni

1412.4	9.8	Lt
16.5	10.0	Lt
21.4	10.2	Lt
30.4	10.5	Lt
76.6	12.5	Ba
82.8	<11.6	M
83.6	12.7	De

Z Cygni

J.D. 242	Est.	Obs.
1483.6	12.6	Ba
88.6	<11.6	V
91.6	<12.2	De

200212
SY Aquilae

1476.6	<12.2	Ba
80.6	12.4	B
83.6	12.4	Ba
90.6	12.6	B
90.6	<12.0	Wh
91.6	<12.2	Bu

200357
S Cygni

1476.6	12.6	Ba
83.6	11.4	Ba

200514
R Capricorni

1427.5	10.4	Lt
30.5	10.2	Lt
32.5	10.2	Lt

200647
SV Cygni

1476.6	9.0	We
76.8	8.8	M
81.6	8.6	Hu
83.6	8.0	Ba
91.6	8.2	Ba
94.8	9.4	M
1502.6	7.9	Ba

200715a
S Aquilae

1411.5	9.3	Lt
16.5	9.3	Lt
30.6	9.4	Lt
72.6	10.7	B
76.3	11.2	L
76.6	11.9	Ba
83 6	11.9	Ba
85.6	11.7	B
90.6	11.8	Wh
91.6	11.9	Bu
91.6	11.9	Ba
1500.6	11.3	B

200715b
RW Aquilae

1472.6	9.2	B
76.6	9.2	Ba
82.6	8.9	R

RW Aquilae

J.D. 242	Est.	Obs.
1483.6	9.4	Ba
83.7	8.8	R
84.7	8.9	R
85.6	9.2	B
86.7	9.0	R
89.7	9.0	R
90.6	9.3	Wh
91.6	9.3	Bu
91.6	9.5	Ba
1500.6	9.2	B

200812
RV Aquilae

1476.6	<12.5	Ba
83.6	13.8	B
83.6	<13.2	Ba
91.6	10.2	Bu
92.6	13.7	B

200906
Z Aquilae

1472.6	8.9	B
76.6	9.0	Ba
83.6	9.0	Ba
85.6	9.0	B
90.6	9.7	Wh
91.6	9.5	Ba
1500.6	9.8	B

200916
R Sagittae

1472.6	9.1	B
75	8.9	T
76	9.3	T
76.6	9.0	Ba
78	9.2	T
80	9.3	T
82	9.2	T
82.6	9.5	R
83	9.1	T
83.6	9.0	Ba
83.7	9.6	R
84.7	9 3	R
85	9.4	T
85.6	9.3	B
86.7	9.6	R
88	9.4	T
89.7	9.5	R
90	9.5	T
90.6	9.8	Wh
91.6	9.5	Ba
95	9.5	T
1500.6	9.1	B

200938
RS Cygni

1411.4	7.7	Vo
12.4	7.9	Lt
13.4	8.0	Lt
16.4	7.7	Vo

RS Cygni

J.D. 242	Est.	Obs.
1416.5	8.2	Lt
17.4	7.7	Vo
21.4	8.1	Lt
22.4	8.2	Lt
32.4	8.4	Lt
76.6	7.3	Ba
76.8	8.5	M
83.6	8.3	De
83.6	7.2	Ba
91.6	7.2	Ba
91.6	8.1	De
94.8	8.4	M
1502.6	7.2	Ba

201008
R Delphini

1476.6	11.2	Ba
77.6	11.1	Wh
77.6	10.7	Cr
78.7	10.7	B
82.6	10.4	O
83.6	10.6	Ba
90.6	10.2	B
90.7	10.3	Wh
91.6	9.6	Bu
1504.6	9.0	O
09.6	9.0	O

201121
RT Capricorni

1476.6	6.5	Ba
83.6	6.6	Ba
86.6	7.4	We
91.6	6.5	Ba
1502.6	6.5	Ba

201130
SX Cygni

1472.6	8.7	B
76.6	8.6	Ba
76.8	8.8	M
83.6	8.8	Ba

201437a
P Cygni

1454.3	5.4	Pe
65.3	5.0	Pe

201521
RT Capricorni

1453.4	7.0	L
77.3	6.5	L

201647
U Cygni

1411.5	8.8	Lt
12.5	8.8	Lt
16.4	8.9	L
21.4	9.0	Lt
22.4	9.1	Lt
27.4	9.2	Lt
32.4	9.3	Lt
76.8	8.6	M

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

U Cygni

J.D. 242	Est.	Obs.
1479.7	8.0	Mu
83.6	7.8	Ba
91.6	8.1	Ba
94.7	9.6	S
94.8	8.9	M
1502.6	7.9	Ba

202539 RW Cygni

1476.6	8.5	Ba
76.8	9.2	M
83.6	8.3	Ba
83.7	9.0	De
87.6	8.6	Wh
91.6	8.2	Ba
91.6	9.1	De
94.8	8.8	M
98.8	9.2	M
1502.6	8.0	Ba

202817 Z Delphini

1476.6	<12.4	Ba
83.6	<13.0	Ba
84.6	<13.6	B
91.6	<11.7	Bu
94.5	13.7	B

202946 SZ Cygni

1457.3	9.6	L
75.6	9.0	Ba
76.6	8.9	Ba
76.8	9.2	M
78.6	9.3	Ba
78.8	9.5	M
82.5	10.0	Ba
82.6	10.0	R
82.6	9.6	Hu
82.8	10.0	M
83.5	9.8	Ba
83.7	9.5	De
84.6	9.7	Ba
84.7	9.8	R
89.5	8.8	Ba
89.7	9.3	R
91.5	8.8	Ba
91.6	9.5	De
94.8	9.4	M
1502.6	8.8	Ba

202954 ST Cygni

1476.6	10.2	Ba
76.8	9.8	M
81.6	10.9	Hu
83.6	10.0	Ba
84.6	10.4	Pi
94.8	11.0	M

203226 V Vulpec.

J.D. 242	Est.	Obs.
1475.4	8.9	T
76.4	9.3	T
76.6	9.3	Ba
78.4	9.2	T
80.4	9.3	T
82.4	9.4	T
83.3	9.2	T
83.6	9.0	Ba
84.3	9.2	T
85.3	9.2	T
88.3	9.0	T
90.3	8.6	T
91.6	8.5	Ba
94.3	8.5	T
95.3	8.4	T
97.3	8.4	T
1502.6	8.6	Ba

203611 Y Delphini

1476.7	<12.1	Ba
83.6	<13.0	Ba
83.6	13.4	B
91.6	<11.4	Bu
93.6	13.3	B

203816 S Delphini

1478.6	9.7	Ba
83.6	8.9	Ba
84.5	9.4	B
97.5	9.4	B

203847 V Cygni

1478.6	11.2	Ba
83.6	9.7	Ba

203905 Y Aquarii

1462.3	<12.2	Pe
91.6	<11.9	Bu

204016 T Delphini

1411.5	9.8	Lt
12.5	9.8	Lt
21.5	9.9	Lt
22.5	9.9	Lt
30.5	10.2	Lt
32.5	10.3	Lt
78.6	11.3	Ba
83.6	12.0	Ba
83,7	10.3	R
84.5	12.2	B
84.6	12.6	Hu
94.5	12.5	B

204017 U Delphini

J.D. 242	Est.	Obs.
1411.4	6.5	Vo
11.6	6.5	Lt
12.4	6.5	Lt
13.4	6.5	Lt
16.4	6.5	Vo
16.5	6.5	Lt
17.4	6.6	Vo
17.5	6.5	Lt
20.3	6.9	Be
21.4	6.5	Lt
22.3	6.9	Be
22.4	6.5	Lt
25.4	6.4	Lt
27.4	6.5	Lt
30.4	6.4	Lt
32.4	6.5	Lt
33.4	6.5	Lt
40.4	6.5	Lt
64.4	6.8	L
77.3	6.7	Be
78.4	6.7	L
82.3	6.7	Be

204104 W Aquarii

1462.3	<13.0	Pe
91.6	<11.3	Bu

204318 V Delphini

1478.6	<12.7	Ba
83.6	<13.0	Ba
84.5	13.0	B
92.5	<12.7	B

204405 T Aquarii

1411.5	9.2	Lt
12.5	9.4	Lt
21.5	10.0	Lt
32.5	11.3	Lt
62.3	12.8	Pe
78.6	12.8	B
78.6	<12.2	Ba
82.6	12.6	Hu
83.7	<13.0	Ba
90.6	12.5	B
91.6	<11.0	Bu

204846 RZ Cygni

1478.6	12.0	Ba
83.7	11.9	Ba
88.6	<10.6	V

205017 X Delphini

1478.6	<12.8	Ba
83.6	13.5	B
83.7	<13.2	Ba
93.5	13.2	B

205030 UX Cygni

J D. 242	Est.	Obs.
1476.6	11.4	Ba
83.7	11.5	Ba

205923 R Vulpeculae

1412.4	9.3	Lt
21.5	9.7	Lt
27.4	9.9	Lt
30.4	10.0	Lt
78.6	11.0	Ba
81.6	10.1	Hu
83.7	10.0	Ba
88.6	9.4	O

210116 RS Capricorni

1453.4	8.4	L
78.4	8.3	L
78.6	7.8	Ba
79.7	8.1	Mu
83.6	7.9	Rd
83.7	7.8	Ba
91.6	7.9	Ba

210129 TW Cygni

1502.6	7.9	Ba
16.4	10.6	Lt
21.4	10.7	Lt
25.4	10.9	Lt
30.4	11.1	Lt
32.4	11.2	Lt
78.6	<12.7	Ba
83.7	13.0	Ba
86.6	12.8	B
94.6	<11.2	V

210382 X Cephei

1494.8	<11.9	M

210812 R Equulei

1477.6	12.2	Re
77.6	12.2	Bu

210868 T Cephei

1411.5	10.5	Lt
12.5	10.5	Lt
21.5	10.5	Lt
25.5	10.4	Lt
32.5	10.4	Lt
77.6	9.0	O
78.3	8.8	L
78.6	8.1	Ba
83.6	8.0	Re
83.6	8.4	Bu
84.6	8.1	Ba
85.6	8.8	O
91.6	8.8	O
94.7	8.4	S
94.7	7.9	Rd

T Cephei

J.D. 242	Est.	Obs.
1494.8	8.2	M
98.6	8.0	Wh
1504.6	8.5	O
09.6	8.2	O

211614 X Pegasi

1478.6	11.5	Ba
84.6	11.4	Ba

211614 T Capricorni

1476.6	9.6	Re
76.6	9.9	Bu
78.6	9.9	Ba
84.6	10.1	Ba

213244 W Cygni

1411.4	6.6	Vo
11.6	6.4	Lt
12.4	6.4	Lt
13.4	6.4	Lt
16.4	6.5	Vo
16.4	6.3	Lt
17.4	6.5	Vo
17.5	6.2	Lt
21.4	6.1	Lt
22.4	6.1	Lt
25.4	6.0	Lt
27.4	6.9	Lt
30.4	5.9	Lt
32,4	5.9	Lt
33.4	5.9	Lt
36.4	5.9	Lt
40.4	5.9	Lt
49.3	6.3	Pe
51.2	6.0	Pe
53.3	5.7	Pe
53.4	5.6	L
57.3	5.9	Pe
59.3	6.0	Pe
64.4	5.6	L
66.3	6.2	Pe
71.3	5.7	L
76.3	5.9	L
81.3	5.8	L
89.5	6.0	Ba

213678 S Cephei

1400.5	10.5	Lt
06.4	10.4	Lt
11.4	13.3	Lt
12.5	10.3	Lt
21.5	10.2	Lt
30.5	9.9	Lt
51.7	10.0	D
53.6	9.9	D
78.6	9.6	Ba

VARIABLE STAR OBSERVATIONS, Sept.-Oct., 1917—Continued.

S Cephei

J.D. 242	Est.	Obs.
1492.6	9.6	Hu
94.7	10.0	S
94.8	10.0	M
98.6	10.4	Wh

213753
RU Cygni

1476.8	8.5	M
78.7	8.4	Ba
83.6	8.8	Bu
84 6	8.7	Pi
84.6	8.2	Ba
96.8	8.6	M

213843
SS Cygni

1411.4	<9.7	Vo
11.5	10.4	Lt
12.4	10.7	Lt
13.4	11.0	Lt
16.4	11.3	Lt
16.4	<9.5	Vo
17.4	11.6	Lt
17.4	<9.4	Vo
21.4	11.9	Lt
22.4	11.9	Lt
25.4	11.8	Lt
25.7	<10.2	D
27.5	11.9	Lt
30.4	11.8	Lt
31.4	11.4	Lt
32.4	10.5	Lt
32.6	10.4	D
33.4	10.0	Lt
35.5	9.6?	Lt
36.4	<9.9	Lt
37.4	<9.9	Lt
40.4	<10.4	Lt
49.6	11.5	D
51.7	11.2	D
53.3	11.4	Pe
53.3	11.3	L
54.6	11.1	D
57.3	9.9	L
58.3	10.2	Pe
59.3	10.0	Pe
62.3	8.4	Pe
63.3	8.3	Pe
64.3	8.3	L
64.3	8.4	Pe
65.3	8.7	Pe
66.3	9.2	Pe
67.3	9.4	L
69.3	9.8	L
72.6	10.5	B
75.5	11.6	Ba
76.2	11.4	L
76.3	11.5	T
76.6	11.3	B
76.6	11.4	Bu
76.6	11.5	Re

SS Cygni

J.D. 242	Est.	Obs.
1476.8	11.5	M
77.6	11.5	Bu
77.6	11.3	B
77.6	<10.4	O
77.6	11.5	Wh
77.6	11.4	Cr
78.3	<11.0	T
78.6	11.5	Ba
78.8	11.8	M
79.7	11.2	Mu
80.3	<11.0	T
80.6	11.6	Cr
80.6	11.7	B
81.3	11.6	L
81.6	11.0	Hu
81.6	11.6	M
81.6	11.5	Pi
82.3	11.5	L
82.3	<11.0	T
82.5	11.6	Ba
82.5	11.7	B
81.6	11.5	Re
82.6	11.5	Bu
82.6	<10.9	R
82.6	<10.4	O
82.6	11.1	D
83.3	11.3	T
83.5	11.6	Ba
83.5	11.6	B
83.6	<9.6	S
83.6	11.4	Bu
83.6	11.5	Pi
83.7	11.2	De
83.7	<10.9	R
84.3	<11.0	T
84.5	11.5	B
84.5	11.5	Ba
84.6	11.5	Pi
84.6	11.0	Hu
84.7	<10.9	R
85.3	<11.0	T
85.5	11.5	B
85.6	<10.0	O
86.5	11.4	B
86.6	11.5	Re
86.6	11.6	Bu
86.7	<10.9	R
88.5	11.4	D
88.6	11.5	Bu
88.6	<10.4	O
88.6	<11.3	V
89.5	11.5	Ba
89.7	<10.9	R
89.8	11.3	M
90.6	11.6	Bu
90.6	11.6	B
90.7	11.5	Pi
91.5	11.6	Ba
91.5	11.6	B
91.6	11.5	Bu

SS Cygni

J.D. 242	Est.	Obs.
91.6	11.3	D
91.6	<10.4	O
91.6	11.9	Hu
91.6	11.5	Pi
92.5	11.3	D
92.5	11.6	B
92.7	11.7	Pi
93.5	11.6	B
93.7	11.6	Pi
93.8	11.8	M
94.3	11.4	T
94.5	11.4	B
94.6	12.1	Wpi
94.6	<11.3	V
94.7	11.8	M
95.3	11.4	T
95.5	11.6	B
95.5	<10.9	Bu
95.5	11.7	Ba
95.6	11.9	Pi
95.6	<10.4	O
95.6	11.6	Re
95.6	11.7	M
95.6	12.1	Wpi
96.8	<11.3	M
97.3	<11.0	T
97.5	11.6	B
97.6	<10.9	Pi
98.5	11.5	B
98.6	<10.2	D
1500.6	11.3	B
00.6	<10.2	D
00.8	<10.4	M
01.5	11.2	±D
02.5	11.5	Ba
02.6	<10.2	D
03.7	11.3	D
04.5	11.3	D
04.6	<11.0	O
05.5	11.5	Ba
08.6	11.0?	O
09.6	<10.4	O

213937
RV Cygni

1476.8	7.3	M
80	8.4	T
81.3	8.3	L
82.6	7.2	Hu
83.6	7.9	Pi
84.6	6.8	Ba
86.6	7.0	B
1502.6	6.7	Ba

214024
RR Pegasi

1477.6	11.2	Wh
78.7	11.8	Ba
80.6	11.2	B
87.7	9.8	Wh
93.5	9.3	B

215605
V Pegasi

J.D. 242	Est.	Obs.
1478.7	12.4	Ba
80.6	11.8	B
93.5	10.0	B
93.6	10.2	Wh

215934
RT Pegasi

1478.7	10.7	Ba
88.6	10.4	V
94.8	10.5	M
95.7	10.9	V

220412
T Pegasi

1478.7	<12.7	Ba
84.6	13.5	B
94.6	13.7	B

220613
Y Pegasi

1478.7	<12.8	Ba
84.6	12.5	Ba
94.6	11.6	B

220714
RS Pegasi

1478.7	<12.8	Ba
84.6	12.3	B
94.6	12.4	B

222439
S Lacertae

1406.5	11.7	Lt
17.4	11.2	Lt
21.5	10.8	Lt
25.5	10.7	Lt
30.5	10.3	Lt
32.4	10.2	Lt
77.6	8.4	O
83.6	9.0	Re
83.6	8.6	Bu
84.6	8.2	B
84.6	8.0	Ba
85.6	8.5	O
89.8	8.2	M
91.6	8.6	O
1504.6	8.8	O

223841
R Lacertae

1413.5	10.0	Lt
16.5	9.7	Lt
17.4	9.6	Lt
21.5	9.6	Lt
25.5	9.6	Lt
30.5	9.6	Lt
32.4	9.5	Lt
89.8	11.4	M

225120
S Aquarii

J.D. 242	Est.	Obs.
1478.7	<12.2	Ba
83.6	<10.7	Re
83.6	<10.7	Bu
94.7	<11.7	Wh
94.7	13.3	B

225914
RW Pegasi

1476.6	12.0	Re
76.6	12.1	Bu
78.7	11.8	Ba
84.6	10.9	B
88.6	11.1	V
93.6	10.5	Wh
97.6	10.8	B

230110
R Pegasi

1449.4	<11.9	Pe
51.4	<12.5	Pe
58.4	12.9	Pe
61.4	12.9	Pe
78.7	12.5	Ba
84.6	<10.1	Pi

230759
V Cassiop.

1416.5	11.2	Lt
21.5	10.7	Lt
25.5	10.1	Lt
32.5	9.7	Lt
51.3	8.5	Pe
53.3	8.3	Pe
57.3	8.0	Pe
58.3	7.9	Pe
59.3	7.8	Pe
62.3	7.7	Pe
63.3	7.7	Pe
66.3	7.4	Pe
71.3	7.3	Pe
76.6	7.3	B
76.6	7.2	De
77.6	7.4	O
79.7	7.3	Mu
81.6	7.0	Hu
84.6	7.0	Ba
85.6	7.9	O
85.6	7.1	B
88.6	7.1	Wh
91.6	7.9	O
94.6	7.8	We
95.6	7.8	O
97.6	7.8	B
1500.8	7.4	M
02.6	7.5	Ba
08.6	8.4	O

VARIABLE STAR OBSERVATIONS Sept.-Oct., 1917—Continued.

231425 W Pegasi

J.D. 242	Est.	Obs.
1481.6	11.2	Hu
82.7	11.0	Ba
88.6	11.2	V
89.8	11.6	M
95.7	11.7	V

231508 S Pegasi

1449.4	11.3	Pe
58.4	12.1	Pe
59.4	11.6	Pe
80.6	12.2	B
82.6	12.3	Re
82.6	12.3	Bu
82.7	12.1	Ba
94.6	12.0	B

233335 ST Androm.

J.D. 242	Est.	Obs.
1482.6	9.3	Hu
82.7	10.0	Ba
83.6	<9.3	S
85.6	10.2	O
85.6	9.7	B
89.8	10.6	M
95.6	10.6	O
1502.6	10.1	Ba

233815 R Aquarii

1482.6	6.8	Bu
82.7	7.0	Ba
84.6	7.2	W
84.6	7.0	B
94.7	6.2	Wh

233956 Z Cassiop.

J.D. 242	Est.	Obs.
1482.7	13.3	Ba

235053 RR Cassiop.

1478.8	<11.1	M

235182 V Cephei

1412.5	6.5	Lt
16.5	6.3	Lt
40.4	6.3	Lt

235209 V Ceti

1482.7	<13.5	Ba
94.7	12.4	Wh

235350 R Cassiop.

J.D. 242	Est.	Obs.
1406.5	11.1	Lt
11.4	11.3	Lt
12.5	11.3	Lt
13.4	11.5	Lt
17.4	11.6	Lt
25.5	11.8	Lt
30.4	11.9	Lt
80.6	12.7	B
82.7	12.7	Ba
84.6	11.9	Hu
92.6	12.6	B

235525 Z Pegasi

1478.8	11.1	M
82.7	10.3	Ba
85.6	9.8	O
88.7	10.5	V

Z Pegasi

J.D. 242	Est.	Obs.
91.6	9.8	O
93.6	9.0	Wh
95.7	8.9	V
1504.6	9.1	O
08.6	9.1	O

235855 Y Cassiop.

1411.5	9.6	Lt
12.5	9.7	Lt
16.5	10.0	Lt
21.5	10.1	Lt

235939 SV Androm.

1476.6	<11.6	Re
76.6	<12.1	Bu
82.6	12.7	De
82.7	12.5	Ba
91.6	<12.9	Hu

No. of Observations 2111; No. of Stars Observed 254; No. of Observers 28.

The Annual Meeting of the Association will be held at Cambridge, Mass. November 10. This meeting is of special importance as we expect to formally organize, adopt a Constitution and By-Laws, and elect Officers. Every member is urged to attend this meeting and expected to notify the Secretary if he intends to be present. Professor E. C. Pickering, Professor Solon I. Bailey and Miss Cannon have accepted invitations to the meeting. Through the courtesy of Professor Pickering, an opportunity will be afforded our members of inspecting the time-honored Harvard College Observatory, which has so much to offer of interest to astronomers.

The following list of calculated dates of maxima is cited from Dr. Hartwig's Catalogue:-

NOVEMBER

Date		Variable		Date		Variable	
1	003179	Y	Cephei	19	141567	U	Urs. Min.
1	194048	RT	Cygni	20	044617	V	Tauri
1	215605	V	Pegasi	21	071713	V	Geminorum
4	*031401*	X	Ceti	21	142539	V	Boötis
6	180531	T	Herculis	21	162815	T	Ophiuchi
9	050953	R	Aurigae	25	013238	RU	Andromedae
9	230759	V	Cassiopeiae	25	123961	T	Urs. Maj.
10	220613	Y	Pegasi	26	214024	RR	Pegasi
11	233335	ST	Adromedae	26	063159	U	Lyncis
15	052036	W	Aurigae	27	011512	U	Piscium
17	184134	RY	Lyrae				

Mr. Leon Campbell contributes the following interesting facts concerning the wonderful Variable 154428 R Coronae which at this writing is once more increasing in brightness and should be observed by each observer at every opportunity.

RECORD OF OBSERVATIONS

1916	Bancroft (Ba)	Benini (Be)	Bolfing (Bo)	Bouton (B)	Bryan (By)	Burbeck (Bu)	Crane (Cr)	Dawson (δ)	Delmhorst (De)	De Perrot (Pe)	Ducharme (D)	Eaton (E)	French (Fr)	Gray (G)	Gregory (Gr)	Hoge (Ho)	Houdard (Hd)	Hunter (Hu)	Lacchini (L)	Leonard (Le)	Lindsley (Ly)	Luyten (Lt)	McAteer (M)	Meeker (Me)	Mundt (Mu)	Nolte (Nt)	Olcott (O)	Phillips (Ph)	
Nov.	290			76		100	36		4			22		56	6	50		33	75	17	39		167		59	36	49	3	1
Dec.	300			93		139	33			6	25			42		17		36	109		26		104	10	37	60	39		
1917																													
Jan.	152			15		100	37			20	11	5		70				39	51		12	183	102	7	17	11	68		
Feb.	260			77		99	23			18	20	5		69				25	55			152	54	19	35	28			
Mar.	241			87	4	33	22				12		1					22	26				56	3	9				
Apr.	246		23	136		119	23		13	11					1			23	185			467	88		22	48			
May	200	11		79	3	59	14			38			10	1			16	31	108			360	104	10	14	26	30		
June	191			32		100	30	26	9	29								21	122			263	42	17	18	13	10		
July				34		58	31	29	13	6									91			420	105	5	52	7	61		
Aug.	150	29		81		29		49	19	38									159			344	96	1	46	2	25		
Sept.	179			110		46		39	17										194				142		18	2	52		
Oct.	369	17		206		81	6		58	94	21						25	39	86			518	163	2	33	4	73		
Total	2578	57	23	1026	7	963	255	143	133	260	89	32	11	238	7	67	41	269	1221	17	77	2707	1223	74	360	237	407	3	5

ANNUAL RECORD OF THE ASSOCIATION.

Year	Number of Observations	No. of stars Observed	Numb Obser
1912	6180	175	19
1913	12914	200	20
1914	14506	255	28
1915	14724	282	29
1916	11261	290	30
1917	15788	332	43
	75373		

VATIONS

Mundt (Mu)	Nolte (Nt)	Olcott (O)	Phillips (Ph)	D. B. Pickering (Pi)	S. W. Pickering (Wpi)	Reardon (Re)	Miss Reed (Rd)	Richter (R)	Spinney (Sp)	Miss Swartz (S)	Vogelenzang (Vo)	Vrooman (V)	Waterhouse (Wa)	Miss Weber (We)	Whitehorn (Wh)	Wilson (W)	Yendell (Y)	Miss Young (Y)	Number of Observations	Number of stars observed	Number of observers
59	36	49	3	109	29			49	15	14		69			23		65	53	1544	242	28
37	60	39		56	8				9	28	47	17	3		36		92	47	1417	223	26
17	11	68		80	4			39		15		26			39		27	20	1140	199	25
35	28			32	16					17	83	20	5		20			49	1181	176	23
9				18	1					13		33			36			36	666	191	18
22	48			45	13					18	61	37			43			40	1661	225	21
14	26	30		65	21					15	46	19			43			39	1332	211	25
18	13	10		81	22	27			12	19	69	25			56		20	36	1290	216	25
52	7	61		27		14				6	33				51		39		1081	152	18
46	2	25		24		17	15	5	30		76				31		32		1298	196	22
18	2	52		18		27	8	70		20				5	73		22		1042	230	18
33	4	73		32	3	36	16	46		15	34	43		15	57	7	44		2136	254	29
360	237	407	3	587	117	121	39	209	66	180	449	289	8	20	508	7	341	320	15788		

ASSOCIATION.

stars erved	Number of Observers
75	19
00	20
35	28
22	29
00	30
22	43

Time elapsing between dates.	Days	
Maximum to minimum	40	plus or minus
At minimum	40	" " "
Minimum to maximum	40	" " "
Maximum to minimum	20	" " "
At minimum	40	" " "

The feature of interest in this record is the 40 and 20 day interval, a regular occurrence in the history of an extremely irregular Variable.

Mr. Luyten leads the list for the number of observations contributed during the past year. There has been a steady growth in the membership of the Association, forty-two observers participating in the recorded work of the year. It is most gratifying to note that we have made a good advance over past records in the number of Variables observed, and more of the Variables are being followed to minima than ever before in the history of the Association.

We again express our obligations to Professor E. C. Pickering and Mr. Leon Campbell for their encouragement and support, and to Professor H. C. Wilson, the Editor of "Popular Astronomy", for his courtesy in publishing the monthly reports.

The Secretary takes this opportunity of formally thanking the individual members of the Association for their loyal efforts to promote the best interest of the Association during the past year. The outlook for the future is indeed bright and we have every reason to expect that the Association will, as time goes on, become a reliable and authoritative factor in solving one of the greatest astrophysical problems the firmament presents.

The following members contributed to this report: Messrs. Bancroft, Beirini, Bouton, Burbeck, Crane, Delmhorst, DePerrot, Houdard, Hunter, Lacchini, Luyten, McAteer, Meeker, Mundt, Nolte, Olcott, D. B. Pickering, S. W. Pickering, Reardon, Miss Reed, Richter, Miss Swartz, Vogelenzang, Vrooman, Miss Weber, Whitehorn, Wilson, Yendell.

WILLIAM TYLER OLCOTT,
Corresponding Secretary.

Norwich, Conn.
October 10, 1917.

Conjunction of the Red Spot Hollow and the South Tropical Disturbance on Jupiter.—The passage of the preceding part of the South Tropical Dark Area being more rapid in diminishing longitude than the motion of the Red Spot Hollow, the former caught up with the latter and was in conjunction with it on March 18, 1917. According to the then rate of motion of both markings the preceding part of the disturbance should emerge from the preceding part of the Red Spot Hollow on or about November 1st. But observations in August and September showed a peculiar darkening ahead of the region of the Red Spot in longitude 44.5 degrees, August 4, 1917; 29 degrees, September 24th; and approximately 23 degrees October 16th. On the latter date a well-formed white loop followed by a dark mass 9.6 degrees in length extended across the south tropical zone.

This now appears to be the preceding part of the South Tropical Disturbance. As can be seen by comparing its position with the longitudes given in my report, Observations of Jupiter in 1915-1916 (POPULAR ASTRONOMY, Vol. XXV, No. 1), this marking, if indeed the preceding part of the disturbance, is far ahead of its predicted position. Its motion as plotted is slightly less than the rotation period of System I.

LATIMER J. WILSON,
President of the Society for
Practical Astronomy.

Bausch and Lomb Observatory,
Rochester, New York,
Oct. 17, 1917.

SS Cygni.—A card from Professor E. C. Pickering, director of Harvard College Observatory, dated Oct. 20, 1917, says: "The star SS Cygni 213843 is of magnitude 8.2 tonight. Observations of its brightness during the next few days are much to be desired."

COMMUNICATIONS.

Mr. Porter's Observatory.—Some time ago you published an account of Mr. Russell W. Porter's Observatory at Land's End, Port Clyde, Maine. I had the great pleasure of visiting him on September 15-17. The evening of September 15 was cloudy so we could not use the telescope, but had a very pleasant time. He has a great outfit, one that anyone should be proud of. The next day was pleasant and we had a good chance to see everything: the Hartness Sun Dial, his first Observatory, all his Arctic souvenirs. He also showed me the method of testing by the knife-edge and eyepiece, which was a great help to me. I saw the original drawing of the Moonscapes published in POPULAR ASTRONOMY some time ago. Mr. Porter has the telescope now fixed so that the reflection is thrown from the siderostat mirror to the parabolic mirror and back through a hole in the siderostat to the eyepiece. We used it on Venus and Jupiter in the evening. After looking through that, my little 6-inch seems rather small, but I hope to build a 12-inch sometime with Mr. Porter's help. I left Port Clyde the morning of September 17 for home, having spent one of the most enjoyable times of my life.

FRANK H. WELCH.

14 Bank Street, Brunswick, Maine,
October 14, 1917.

The Number of Planets Known to the Ancients.—In the several books I have read on astronomy, I have gained the impression that only five planets were known to the ancients.

I beg to call your attention to the following from the works of Josephus (Whiston) Antiquities of the Jews. Chap. VII, verse 7. Commencing on the 24th line I quote as follows:

"By branching out the candlestick into seventy parts, he secretly intimated the Decani, or seventy divisions of the planets; and as to the seven lamps on the candlesticks, they referred to the course of the planets, of which that is the number."

It was suggested to me that he included the sun and moon with the planets, but further on in the same chapter, starting in the 53rd line he says as follows:

"Each of the sardonyxes declares to us the sun and the moon;"

Trusting that this might be of interest to your readers,

WM. M. ALLEN.

Red Bluff, California,
October 11, 1917.

GENERAL NOTES.

Dr. Otto Klotz has been appointed Chief Astronomer and Director of the Dominion Astronomical Observatory at Ottawa.

Dr. R. F. Sanford, Fellow in the Lick Observatory for the year 1916-17, has accepted an appointment in the Dudley Observatory, Albany, New York, dating from July 1, 1917. We have recently learned that he is to become assistant in spectrographic work at the Mount Wilson Solar Observatory at the beginning of the coming year.

Mr. C. M. Huffer, a graduate of Albion College, Michigan, and more recently a student at the University of Illinois, has been appointed D. O. Mills Assistant in the Lick Observatory and is now at work with Dr. R. E. Wilson at Santiago, Chile.

Mr. A. A. Scott, Assistant at the D. O. Mills Observatory, Santiago, Chile, since 1913, has resigned and returned to the United States.

Mr. Holger Thiele has been appointed Fellow in the Lick Observatory for the year 1917-18 and is now in residence. Mr. Thiele was assistant in the Observatory at Bamberg, Bavaria, in 1900-01, in the Observatory at Copenhagen 1901-07 and in the Observatory at Bergedorf, Hamburg, from 1908 to February 1917.

Dr. F. C. P. Henroteau, of Brussels, has been appointed Martin Kellogg Fellow in the Lick Observatory for the year 1917-18. Since leaving Brussels, in August 1914, Dr. Henroteau has spent fourteen months in work at Stonyhurst College Observatory, in England, and nearly a year and a half at the Detroit Observatory, Ann Arbor, Michigan.

Astronomer R. G. Aitken of the Lick Observatory received the degree of Doctor of Science from Williams College at the Commencement, June 25, 1917.

Professor A. O. Leuschner, director of the Astronomical Department of the University of California, at Berkeley, has been delegated by the Director of Instruction in the Navigation Schools of the United States Shipping Board, to administer the details of instruction on the Pacific Coast and in particular to provide qualified instructors. On his recommendation the new navigation schools have been completely manned at San Francisco, San Diego and San Pedro, California, and Portland and Astoria, Oregon, and work began in the latter part of August.

Dr. S. Einarsson and **Dr.F. J. Neubauer** of the Berkeley Astronomical Department are devoting half time to instruction in the Navigation School at San Francisco and half time to work in the department at Berkeley.

Dr. H. D. Curtis, Astronomer at the Lick Observatory, is giving instruction in the Navigation School at San Diego.

Mr. W. F. Meyer, of the International Latitude Observatory at Ukiah, California, is giving instruction in the Navigation School at San Pedro.

Mr. C. D. Shane, Fellow at the Lick Observatory, is giving instruction in the Navigation School at Astoria, Oregon.

Dr. Arthur Williams (Ph. D. California, Mathematics 1916) is giving instruction in the Navigation School at Portland, Oregon.

Dr. J. D. Maddrill, formerly in charge of the International Latitude Station at Ukiah, California, has been appointed actuary of the United States Bureau of Efficiency at Washington, and in this capacity will assist in working out the details of insurance to be offered to soldiers and sailors by the United States Government.

Mr. Wallace Campbell has resigned his Teaching Fellowship at Berkeley to accept a commission in the Engineering Corps of the National Army.

Mr. Carlos S. Mundt has been appointed Teaching Fellow to fill the vacancy caused by Mr. Campbell's resignation.

Mr. H. M. Jeffers has been appointed assistant in the Berkeley Astronomical Department on part time. He is also instructor in the new department of Military Aeronautics in the University of California. **Miss A. L. Beck** has been appointed assistant and **Miss D. L. Schwan** reader in the Department.

Dr. D. Alter resigned his Instructorship in the University of California to accept the position of Assistant Professor in Astronomy in the University of Kansas. In May he entered the R. O. T. C. with a commission as second lieutenant in the Coast Artillery.

Mr. John A. Cook, of Macon, Missouri, who has been an occasional contributor to POPULAR ASTRONONY, died at his home on Sunday October 14, at the age of fifty-nine. Mr. Cook, although a business man, was much interested in astronomy. He built a private observatory which was frequently open to the citizens of Macon, and devoted much time to showing and explaining to his guests the wonders of the sky.

Parallax of the Ring Nebula in Lyra.—Mr. A.van Maanen has recently completed a determination of the parallax of the central star in the Ring Nebula from 14 photographs taken with the 60-inch reflector of the Mount Wilson Solar Observatory. The exposures were of 25 or 30 minutes duration with the reflector arranged so that the equivalent focal length was 80 feet. Nine stars were used for comparison, yielding the following relative parallax:

$$\pi = +0''.002 \pm 0''.005$$

"The absolute parallax would be $\pm 0''.004$. This value points to enormous dimensions for the nebula itself; the major and minor axes would be 330 and 250 times the diameter of the orbit of Neptune. Adopting 14.1 as the visual magnitude of the central star, the parallax found here gives a very low value for its absolute magnitude, viz., +7.1."

The visual magnitude of the central star, however, must be fainter than 14.1, since it is not visible with the 16-inch telescope of Goodsell Observatory, with which we are able to detect stars of magnitude 15.5, on the Harvard scale, under conditions of best seeing.

Nova Persei.—In Bulletin 646 of the Harvard College Observatory Professor Pickering gives the following quotation from a letter from Dr. Walter S. Adams of the Mount Wilson Solar Observatory:

"Mr. Pease and myself obtained a photograph of the spectrum of Nova Persei with a low dispersion spectrograph and the sixty-inch reflector on the night of September 26. The spectrum shows no variation that we can detect from that observed on November 1913. It is of the Wolf-Rayet type with strong bright hydrogen lines and λ 4686."

New Stars in Spiral Nebulae.—In the August 1917 number of the *Publications of the Astronomical Society of the Pacific*, Dr. H. D. Curtis, in referring to the discovery of a new star in the spiral nebula N. G. C. 6946 by Professor G. W. Ritchey at Mount Wilson, calls attention to the fact that six novæ have now been discovered within the boundaries of spiral nebulæ. Three of these have recently been found by Dr. Curtis on photographs, taken with the Crossley reflector, of the spirals N. G. C. 4527 and 4321. The other two are *Nova Andromedæ*, which appeared suddenly in August 1885, only a few seconds from the nucleus of the Great Nebula of *Andromeda*, and the nova Z *Centauri* which appeared at a distance of only 28″ from the nucleus of the spiral nebula N. G. C. 5253.

Dr. Curtis says: "It is possible that a single nova might appear, so placed in the sky as to be directly in line with a spiral nebula, tho the chances for such an occurrence would be very small. But that six new stars should happen to be thus situated in line with a nebula is manifestly beyond the bounds of probability; there can be no doubt that these novæ were actually within the spiral nebulæ. The occurrence of these new stars in spirals must be regarded as having a very definite bearing on the 'island universe' theory of the constitution of spiral nebulæ."

This note by Dr. Curtis called out several other notes in regard to probable novæ in spiral nebulæ in the October number of the *Publications*. Mr. Ritchey calls attention to a nova in the nebula H IV 76 *Cephei* (N. G. C. 6946) and to stars which are either variable or novæ in Messier 81 (N. G. C. 3031), H V 44 *Camelopardalis* (N. G. C. 2403), Messier 101 (N. G. C. 5457-8) and the Andromeda nebula. Mr. Francis G. Pease announces a suspected nova in the Nebula N. G. C. 2841. Mr. Harlow Shapley announces a faint nova in the Andromeda nebula and in another note gives a list of 11 temporary stars which have appeared in spiral nebulæ. This list includes those which have been mentioned above. He says: "Six of the objects are situated in spiral arms, three in denser nuclear parts, and the other two apparently at some distance from nebulosity, but longer exposures would perhaps show connecting spiral arms."

Both Curtis and Shapley call attention to the fact that all the other new stars which have been discovered, excepting T *Coronae* which was not a typical nova, have been within the Milky Way, which may be really of a spiral structure. Conversely, by analogy, the spiral nebulæ may be congeries of vast numbers

of stars, at too great distances to be resolved into individual points of light. The difficulty in accepting this conclusion is the inconceivable distances at which the spiral nebulæ must lie. According to Shapley's plausible reasoning the Andromeda nebula, probably the nearest of the spirals, must be at a distance of something like a million light-years. At that remote distance the diameter of this largest of the spirals would be about 50,000 light-years, and would compare in size with our own galactic system.

List of Temporary Stars in Spiral Nebulae.—This list is given by Mr. Harlow Shapley, in *Publications of the Astronomical Society of the Pacific*, October, 1917. The right ascensions and declinations are added by the Editors of POPULAR ASTRONOMY.

No.	N.G.C.	Position of Nucleus 1900 α		δ	Galactic Latitude	Observed Maximum	Date of Observed Maximum	Distance from Nucleus	Discoverer
		h	m	°	°	m		″	
1	224	0	37.3	+40.7	−20	7.	Aug. 1885	16	Hartwig
2	5253	13	34.3	−31.1	+30	7.	July 1895	32	Mrs. Fleming
3	4321	12	17.9	+16.4	+77	13.5	Mar. 1901	110	Curtis
4	3147	10	08.3	+73.9	+40	13-14	Apr. 1904	340	Mrs. Isaac Roberts
5	224	0	37.3	+40.7	−20	16.3	Sept. 1909	249	Ritchey
6	224	0	37.3	+40.7	−20	17.0	Sept. 1909	198	Ritchey
7	2841	9	15.1	+51.4	+45	16	Feb. 1912	54	Pease
8	4321	12	17.9	+16.4	+77	14	Mar. 1914	111	Curtis
9	4527	12	29.0	+ 3.2	+64	14	Mar. 1915	45	Curtis
10	6946	20	32.8	+59.8	+12	14.6	July 1917	111	Ritchey
11	224	0	37.3	+40.7	−20	17.5	Sept. 1917	600	Shapley

Parallax of Barnard's Star of Large Proper Motion.—From a personal letter from Dr. A. van Maanen, we get the information that a preliminary parallax of Barnard's Star of large proper motion, based upon ten exposures, is found to be $+0''.519 \pm 0.005$.

Two Important Astronomical Discoveries.—In Bulletin No. 1 of "Results of Researches on the Electrodynamic Wave Theory of Physical Forces", Dr. T. J. J. See, astronomer at the Mare Island Naval Observatory, announces two discoveries in Celestial Mechanics which, if verified when the details of the mathematical discussion are published, will prove exceedingly important and greatly advance our mastery of the problem of the universe.

One of these discoveries is "The physical cause of universal gravitation", the other "The physical cause of the hitherto unexplained fluctuations in the moon's mean motion", which offers, if true, a very strong confirmation of the first.

Dr. See makes electrodynamic wave motion the cause of gravitation and states that this wave motion is propagated with the velocity of light. Weber's fundamental electrodynamic law is shown to be the law of nature. His formula

$$F = \frac{mm'}{r^2}\left\{1 - \frac{1}{c^2}\left(\frac{dr}{dt}\right)^2 + \frac{2r}{c^2}\left(\frac{d^2r}{dt^2}\right)\right\}$$

in which m and m' are the masses, r the distance and c the velocity of transmission for the wave action, reduces to Newton's law

$$F = \frac{m\,m'}{r^2}$$

when the orbit is circular, so that $\frac{dr}{dt} = 0$ and $\frac{d^2r}{dt^2} = 0$.

The fluctuations of the moon's motion hitherto unexplained are produced by the modification of the gravitational waves when they must pass through the body of the earth in order to reach the moon. The sun's action is thus weakened when the moon is near the shadow of the earth.

Maria Mitchell Memorial Fellowship at Harvard Observatory.—This Astronomical Fellowship of $500 is offered to a woman for the year beginning September 15, 1918.

A competitive examination will not be held. The candidate must present evidence of qualifications under the following heads:

1. A letter from the candidate addressed to the Secretary of the Committee, giving an account of previous educational opportunities and training, and of plans for future work.
2. College diploma or a certificate from the registrar of her college, and if she has already held a position as instructor or teacher in any college or other institution, a clear statement of the work done, together with a certificate as to the quality of work.
3. Examples of work already accomplished.
4. Testimonials as to ability and character.
5. Satisfactory evidence of thoroughly good health.

The fellowship at all times must be used for purposes of serious study, and the fellow should be as free as possible from other responsibilities.

Applications for the year beginning September 15, 1918, should be made under the above heads, and must be in the hands of the Secretary of the Committee, Mrs. Charles S. Hinchman, 3635 Chestnut Street, Philadelphia, Pennsylvania, on or before April 1, 1918.

COMMITTEE

Prof. Mary W. Whitney, Director Emeritus of Vassar College Observatory, *Honorary Chairman.*
Annie J. Cannon, A. M., Curator of Astronomical Photographs, Harvard College Observatory, *Chairman.*
Prof. Edward C. Pickering, Sc. D., Director of Harvard College Observatory.
Prof. Anne S. Young, Ph. D., Director of Mt. Holyoke Observatory.
Prof. John C. Duncan, Ph. D., Director of Whitin Observatory, Wellesley, Mass.
Elizabeth R. Coffin, A. B., Vassar College, 1870, Nantucket, Mass.
Florence M. Cushing, A. B., Vassar College, 1874, Boston.
Lydia S. Hinchman, *Secretary*, 3635 Chestnut Street, Philadelphia.

A New Meteorite.—The following, taken from *Science*, September 14, 1917, refers to the meteors described by Mr. John Koep in the August-September number of POPULAR ASTRONOMY:

About 6:20 P. M., July 4, 1917, there fell within the corporate limits of Colby, Wis., in the western part of the city, which is in the county of Clark, an achondritic aerolite, the fall of which was witnessed by a considerable number of people.

Unfortunately, knowledge of this fall did not come to me until two weeks later and a visit to the locality was made on July 24, at which time the stones had become considerably broken up and dispersed.

Two pieces fell, the smaller about one half mile NNE. from the other. The larger stones fell in a pasture, striking a granite rock, at least two inches in thickness, lying upon or near the surface, breaking this rock into many fragments and itself breaking into twenty-seven or more pieces. The larger mass, weighing 22¾ pounds, penetrated the stiff Colby clay to a depth of five feet. Some of the smaller pieces are said to have distributed themselves laterally in the soil to the extent of about four feet.

The smaller stone fell in a cultivated field without breaking and is said to have penetrated the soil about two feet. This stone is variously described as about 10x14x3 or 4 inches, 17 or 18 inches by 9x9 inches and 21x11x11 inches at larger end, sloping in two directions to a wedge shape with rounded corners. This piece was said to be entirely covered with crust and to have weighed from 75 to 85 pounds.

The man who extracted it from the earth informs me that it was so cold that frost immediately formed on its surface when exposed to the air.

The Public Museum of the City of Milwaukee has obtained the bulk of the larger mass, which will be analyzed and duly published. It will probably be distributed in exchange with several museums.

The stone is of light gray groundmass, apparently largely feldspathic, containing very few chondrules and thickly shot with pyrrhotite varying from specks a fraction of a millimeter to more or less globular masses 5mm in diameter. It exhibits sundry black veins and armored surfaces. Its crust shows considerable variation on different pieces, some of which are deeply pitted and others comparatively smooth.

This is, I believe, the sixth meteorite known from the state of Wisconsin and will be known as the Colby meteorite.

HENRY L. WARD.

Public Museum of the City of Milwaukee.
July 31, 1917.

The Bruce Medal Not Awarded for 1917.—At the August meeting of the Astronomical Society of the Pacific, the following resolution was adopted:

Resolved: That, on account of existing international conditions, the Directors of the Astronomical Society of the Pacific deem it advisable that no award of the Bruce Medal be made for the year 1917.

PARADOXICAL.

"Our consciences are like our watches; prone
Is man to doubt all others save his own."
So saith the poet; but the thought occurs,
He made exceptions of astronomers.
High-minded men, each with a faith sublime
Sets his own conscience by sidereal time;
And thus where'er abroad they chance to be,
Each pulls his watch; when lo, they all agree!

C. E. BARNS.

Morgan Hill, California.